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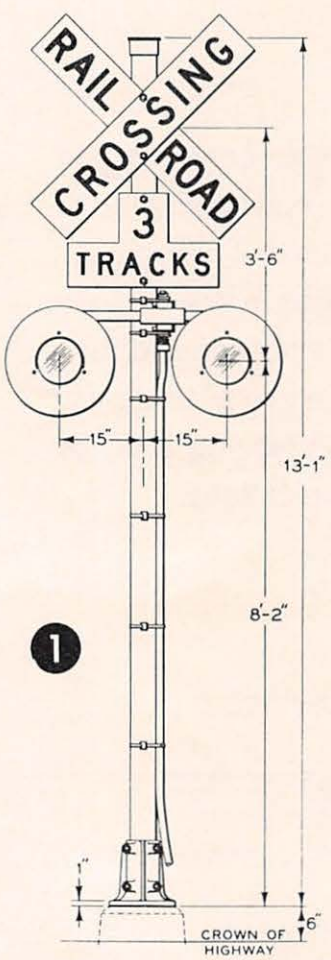

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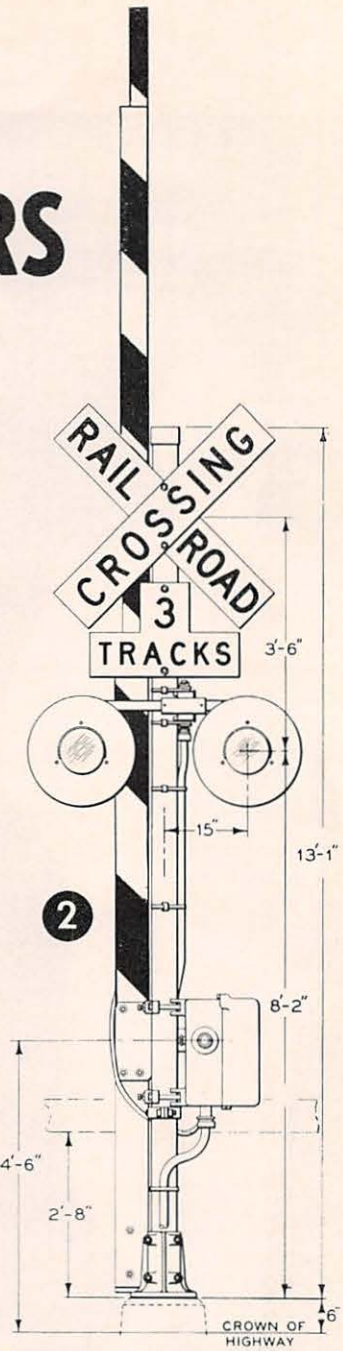

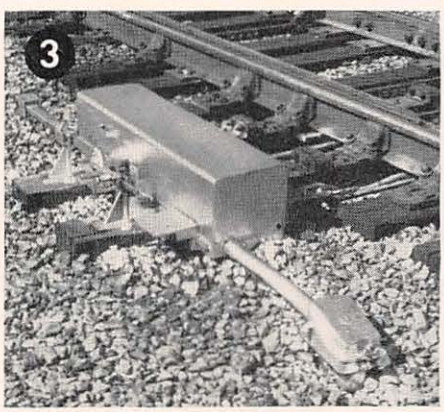

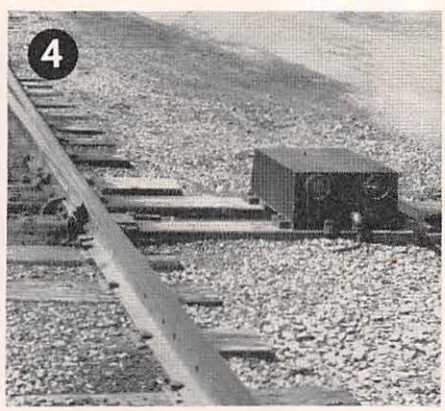

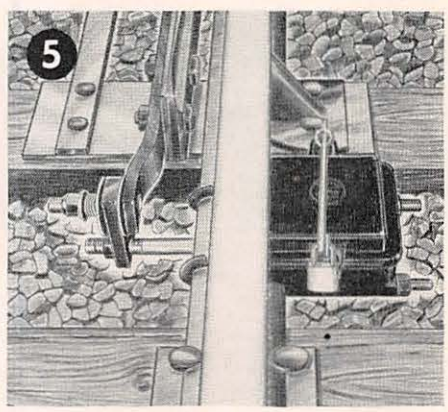

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Circle 5 on reader service card

MARCH 1970 VOL. 63 NO. 3

RSC RAILWAY SIGNALING AND COMMUNICATIONS

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OUR NEW COVER: After 60 years of advertising in Railway Signaling and Communications on the cover, The Kerite Company has graciously surrendered its cover position to permit an editorial cover, in the interest of all readers and advertisers. Their advertisement is on the center spread.

Published monthly by Simmons-Boardman Publishing Corporation, 508 Birch St., Bristol, Conn. 06010, with executive office at 30 Church St., New York, N.Y. 10007. Second class postage paid at Bristol, Conn. 06010 and at additional mailing offices.

Member of the Audit Bureau of Circulations (A.B.C.) Name registered in U.S. Patent Office. Printed in U.S.A. by the Johnson Press, Inc., 800 North Court St., Pontiac, Ill. 61764.

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Subscriptions: Address all subscriptions and correspondence concerning them to: Circulation Department, Railway Signaling and Communications, P.O. Box 530, Bristol, Conn. 06010. Change of address should reach us three weeks in advance of the next issue date. Send old address with the new, enclosing if possible your address label. The Post Office will not forward copies unless you provide extra postage. Duplicate copies cannot be sent.

Subscription price to railroad employees only in U.S., Possessions, Canada and Mexico, $3.00 one year, $5.00 two years. All others $6.00 one year, $9.00 two years. Payable in advance and postage free. All other countries: $8.00 one year, $16.00 two years. Single copies 75¢.

POSTMASTER SEND FORM 3579 TO P.O. BOX 530, BRISTOL, CONN. 06010.

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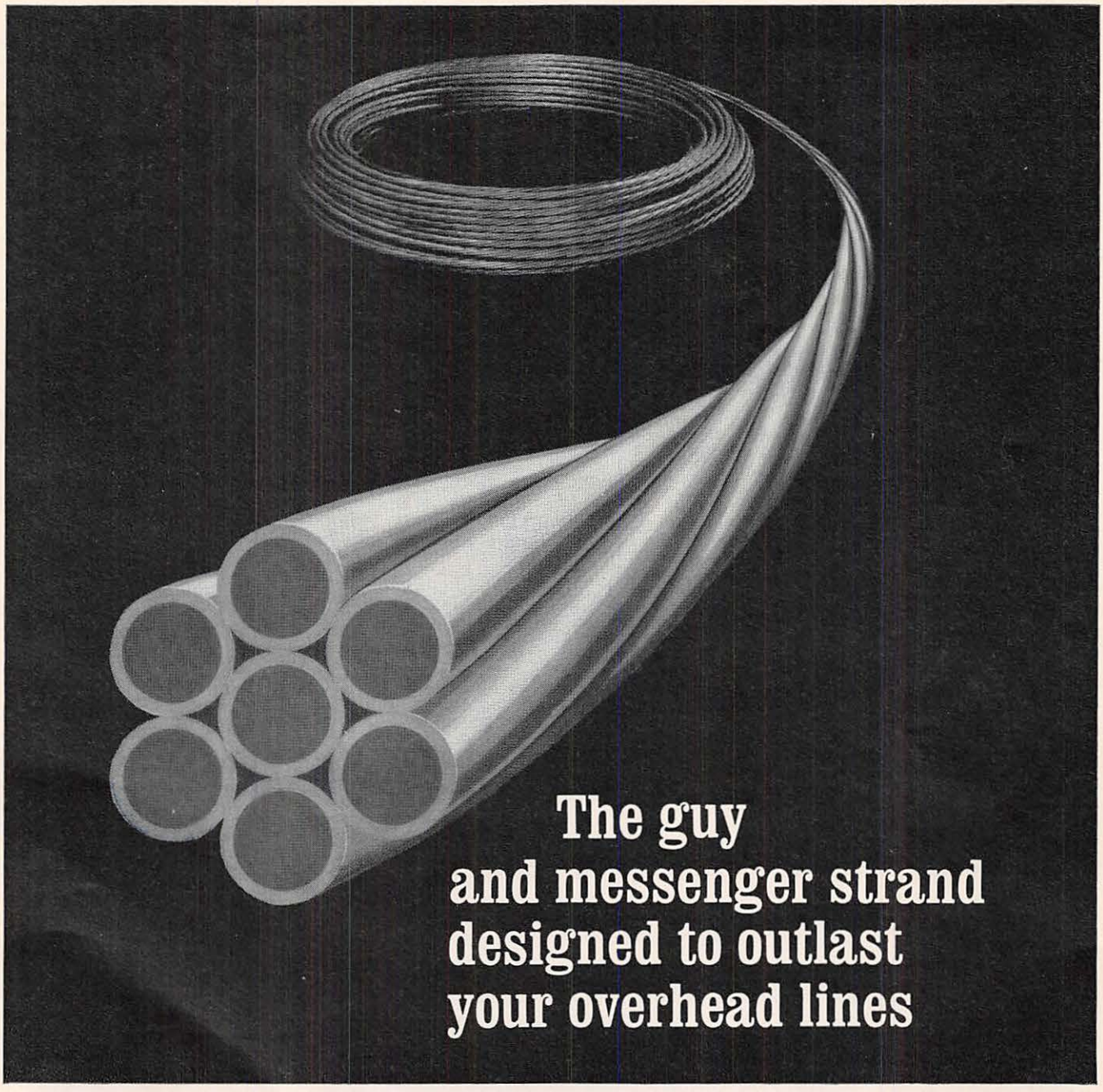

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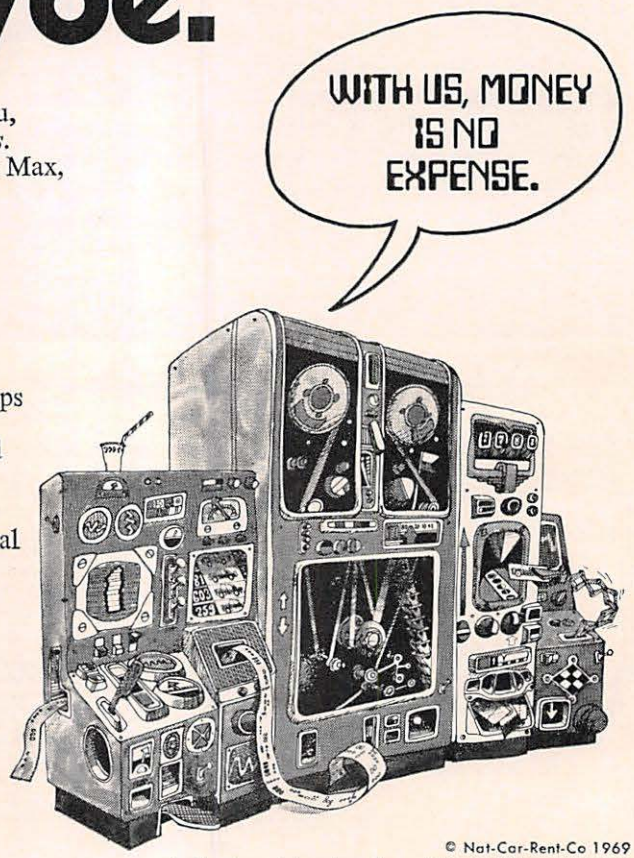

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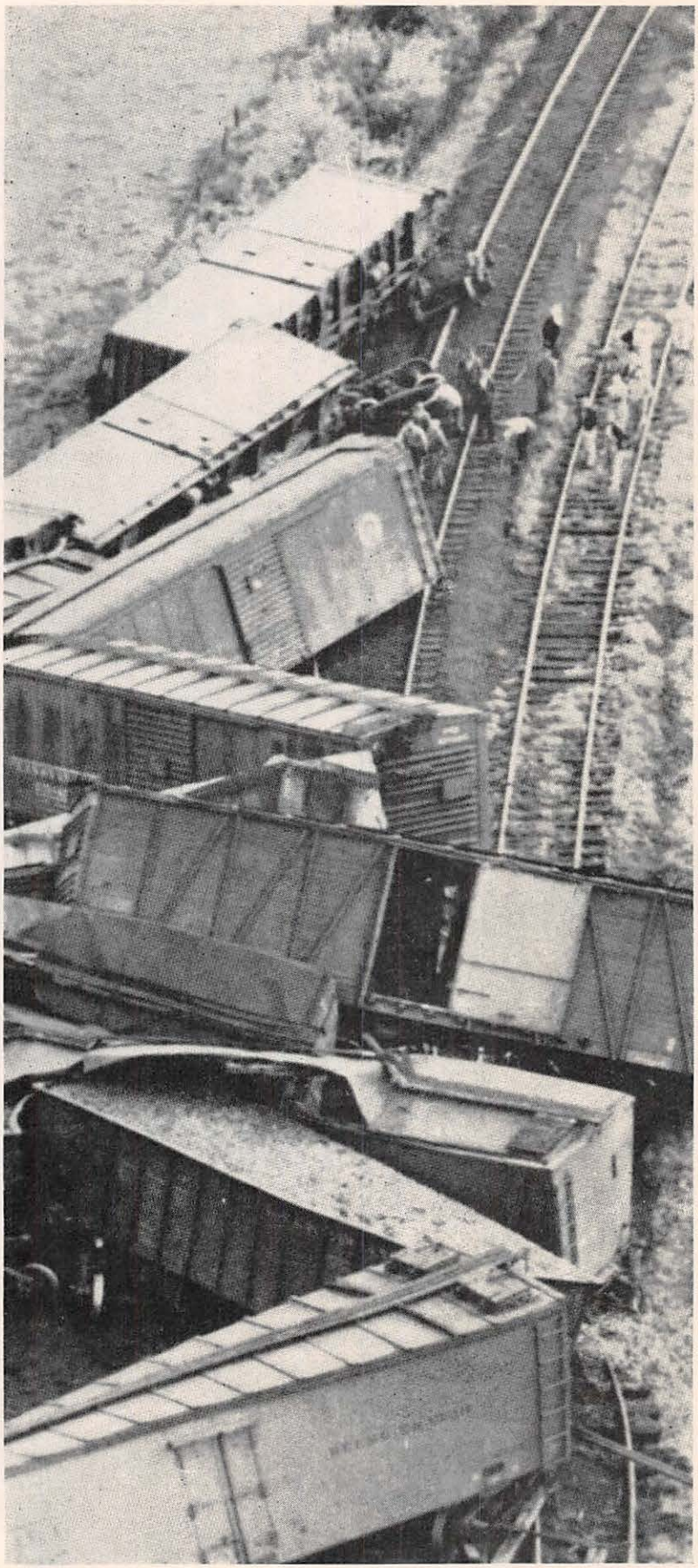

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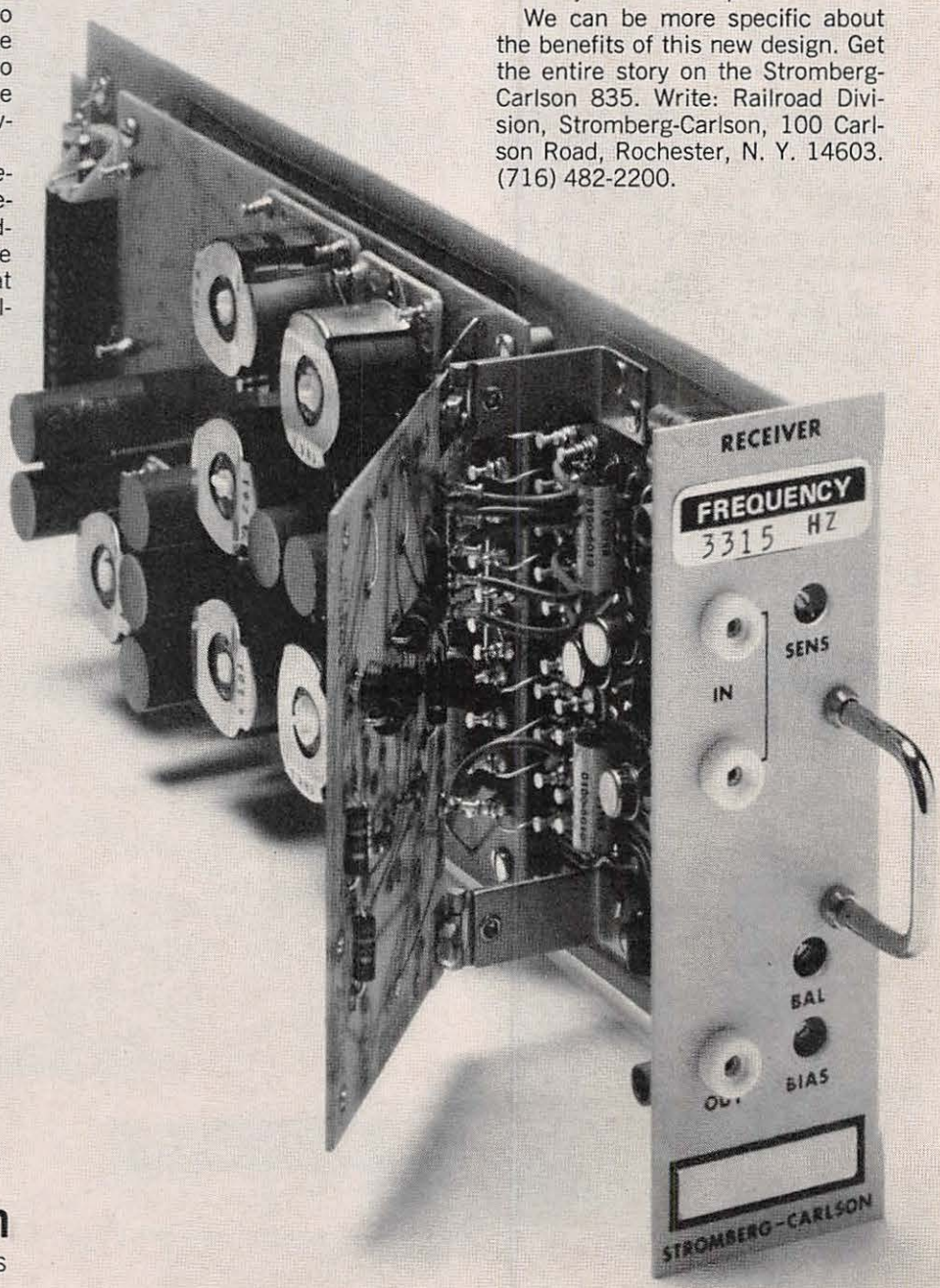

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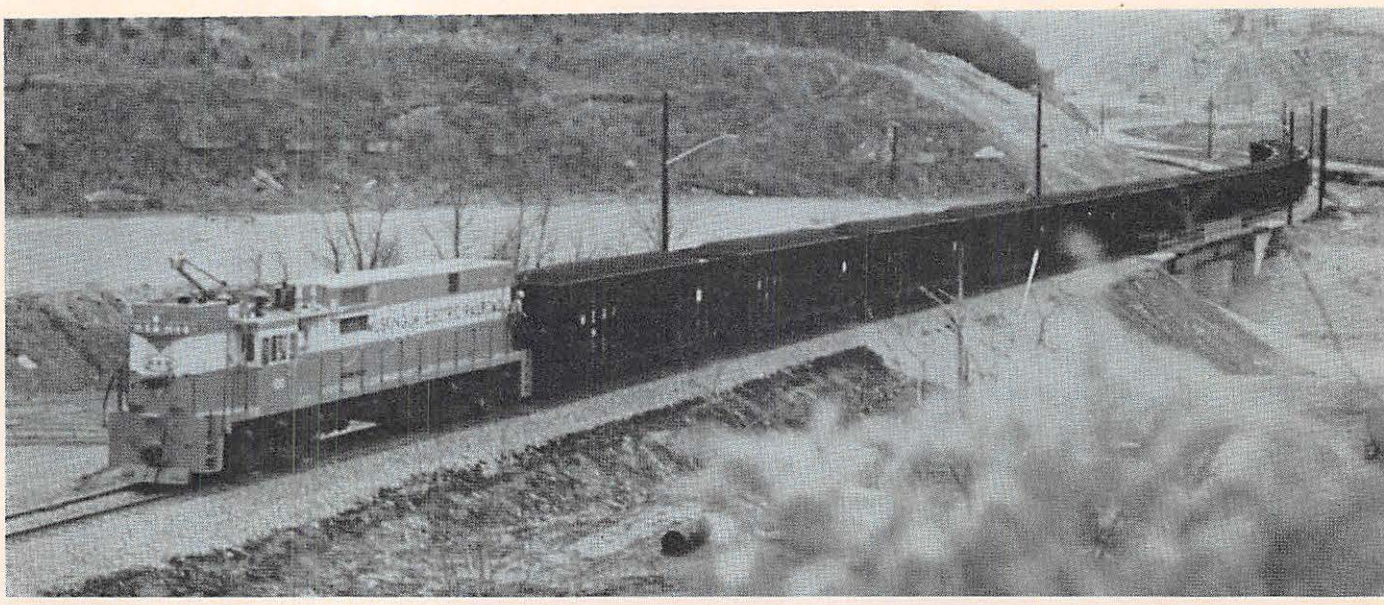


MUSKINGUM ELECTRIC 5,000 hp locomotive hauls loaded coal train under 25 kv, 60 Hz catenary power.

Electrification outlook brightens

Renewed interest in railroad electrification is due to a new look at the economics, plus the greater interest in air pollution and other environmental controls.

The decade of the Seventies may see a revival of interest in railroad electrification almost as great when electrification peaked in the United States, about 1930. Some experts predict that there may be as much as 10,000 road miles of electrification in the U.S. by 1980.

Rising diesel fuel costs, the demand for better service (running heavier trains at higher speeds, or many short trains), greater capacity of electric power companies to provide power at reasonable rates at the "catenary," the demand by the public for air pollution controls, and utility companies needs for more rights-of-way for power transmission lines, strengthen the belief of the experts that electrification of U.S. railroads may see a resurgence in the decade ahead.

John W. Barriger, president, Missouri-Kansas-Texas, has predicted that by 1980 straight electric locomotion will be producing 90% of the rail freight traction in the U.S., and in all other highly developed countries. He estimates that this 90% may be running over 10-20% of the mainline trackage.

Some utilities have already obtained permits to construct high-voltage transmission lines on railroads' rights-of-way. Knowledgeable persons in the industry predict that there could be a profitable trade-off for railroads and utilities. The railroads would provide transmission line space, and for this, the utilities would provide reasonable power rates at the catenary. This would gain them new customers. The railroads would gain some revenue from the air rights, and with reasonable power rates could probably justify electrification. One suggestion has been for the utility to construct the transmission towers and power lines, while the railroad would install the catenary and maintain it.

With power companies desiring more complete intertie facilities so that power can be shifted from one area to another, they will be looking for more rights-of-way for transmission lines. Near centers of population (high electricity usage), the railroads have the access routes.

By electrifying, the railroads could help their own coal hauling business of supplying the power companies with this necessary fuel.

The cover picture, and the one above are of the automated coaling hauling trains operating on the Muskingum Electric Railroad, near Zanesville, Ohio. Two trains haul a minimum of 90,000 tons weekly from a Central Ohio Coal Co. tipple 15 miles to the Muskingum river power station stockpile.

Electrification growth seen on

About 2,400 route miles of rail and transit lines are electrified in the United States. Another 172 miles are under construction. Of this total, now in operation, 685 route miles of line are handling freight trains only, while another 838 miles of electrified lines are handling freight and passenger operations. Passenger or commuter service is now being operated over 424 miles of electrified territory. Rapid transit operations account for another 481 miles of electrified territory. New transit systems under construction in Washington, D.C. and San Francisco, Calif. account for 172 miles of electrified territory.

Except for the Muskingtum Electric, all new construction of electrified lines in the last decade or so has been in the area of rapid transit or commuter service. However, there is a growing interest in electrification in the U.S., particularly on the part of the two necessary participants—the railroads and the electric utility industry.

E. O. George, president, Detroit Edison Co., said: "Railroad electrification is a segment of the transportation market that can be developed now. We don't have to wait for new technology, the need exists and in large measure the market is ready. Representing a potential load second only to electric home heating, railroad electrification offers us the opportunity to move immediately into the transportation market on a meaningful scale."

Several reasons are given for making electrified railways economical and practical, according to George. One is the development of the rectifier locomotive which can operate off 60 Hz commercial frequency. Another improvement has been an increase in capacity and geographical spread of electric companies providing greater access to railroads. These high-capacity systems have, in many instances, been interconnected so that there is no longer any problem of handling the large single-phase loads to meet railroad electrification requirements. Technological advances in central station generation, plus economies of large interconnected systems have generally offset rising costs. "The price of electric energy on a relative basis has been substantially reduced making it competitive with other railroad motive power fuels," George said.

"With faster, more dependable service, with new operating and marketing techniques such as unit trains and piggyback service, railroads . . . have placed themselves in a better competitive position than at any time in the past." But to compete in the growth potential, George said, "the railroads must be able to provide customers with even faster, more economical service.

"This need for speed and economy suggests electrification as the next logical step. For speed means horsepower, and horsepower is more easily built into an electric locomotive. For equivalent weight and space, straight electrics can be built to produce over twice the horsepower of a diesel."

For economy and other service improvements too, electrification offers a number of impressive advantages:

- The economic life of an electric locomotive is at least double that of a diesel.
- Maintenance costs are one-quarter to one-third as much.
- The amount of time a modern electric locomotive is available for service has been shown to be much greater than the diesel which allows for improved availability and scheduling.
- Better utilization of rolling stock is possible with electric motive power because of increased acceleration and shorter turn-around time.
- Electric motive power is cleaner and quieter. These are intangible, difficult-to-measure benefits. But in view of increasing urbanization and existing public interest in air pollution, their importance cannot be overlooked.

"A major advantage of electric motive power is its intrinsic overload capacity for short periods. This serves greatly to increase the effective rating of diesel-electric locomotives at low speeds and of electric locomotives throughout their entire speed range. As an example, a short grade may require capacity for, say 15 minutes, which may not be required for longer periods

MANAGEMENT INFORMATION

At present there are slightly over 2500 route miles of railroads and transit systems in the United States in operation or under construction that are electrified. Railroads account for 1,947 route miles of electrification and rapid transit operations account for 481 miles.

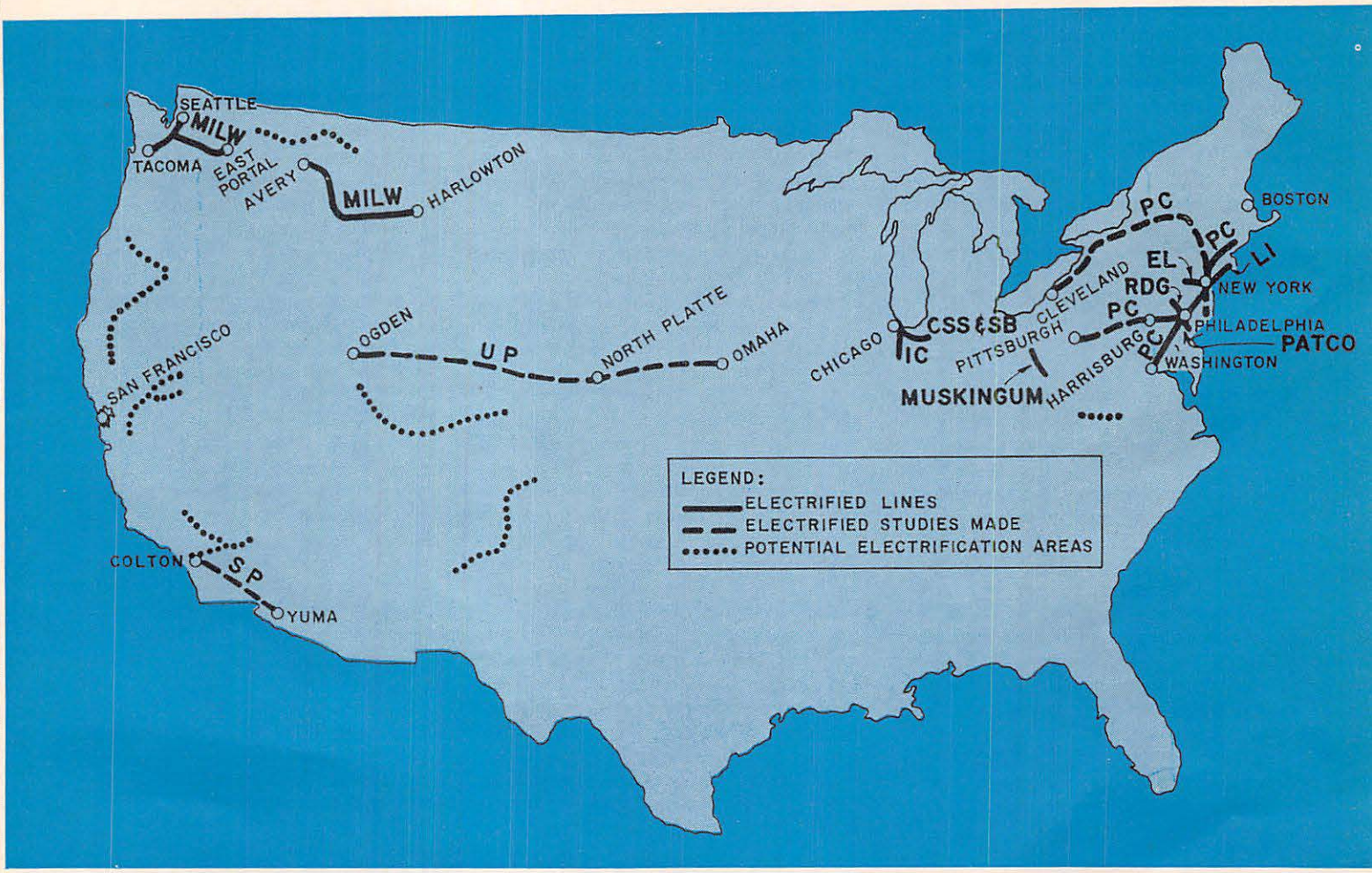
By the start of World War II, most railroad electrification now in service had been installed. Some rapid transit lines have been constructed in recent years. Technological breakthroughs, here and particularly in Europe, have improved the outlook for electrification. One is the ability of power companies to be able to handle the large 60 Hz, single-phase load of electrification from a three-phase power system. Use of the 60 Hz, standard frequency, eliminates the cost of converting to another frequency. Also, at higher voltages—consideration is given to 25 kv or 50 kv, 60 Hz systems—the installation of current carrying catenary wire is less costly and a smaller number of substations are required.

Of equal importance is the development of silicon controlled rectifiers for conversion of the 60 Hz AC of the transformer aboard the locomotive to direct current to operate the traction motors. DC traction motors have proved to be best suited for rail hauling operations. DC traction motors are used in diesel-electric locomotives as well as on rapid transit cars.

Experts have indicated that, generally speaking, for equivalent weight and space, straight electric locomotives can be built to produce over twice the horsepower of a diesel-electric locomotive. Also, it has been determined that the economic life of an electric locomotive is at least 30 years or more.

A large deterrent to further electrification in recent years has been lack of capital by the railroads to invest in catenaries, motive power and system modifications. However electric utilities have shown interest in providing the catenary part of electrification, possibly in a trade-off for right-of-way privileges for transmission lines. Edison Electric Institute and several power companies are studying this matter with interested railroads. If predicted traffic growths become reality during this decade of the Seventies, electrification may well become the economic salvation of the railroads.

transit and railroads



HIGH TRAFFIC DENSITY and/or mountains are potential areas for electrification of mainline railroads.

and for which the overload capacity of traction motors and transformers may well be suited. Starting from stops or accelerating after slowdowns may also utilize overload capacity to advantage in maintaining fast schedules with heavy and high-speed trains," states Frederick N. Houser, editor, *Railway Locomotive & Cars*, in 10th edition of *Standard Handbook for Electrical Engineers*.

With all the technical advantages of electrification, why have there not been more installations? The answer is economic. Speaking at the International Electric Vehicle Symposium at Phoenix, Ariz., last November, George explained the economic aspects of electrification, as follows:

"Total capital expense for an electrified railway can be divided roughly into three equal parts: catenaries, motive power and system modifications. In the past, the railroad industry has assumed responsibility for all of these. Today, however, it would be unrealistic to expect that they would be either willing or able to undertake such a massive capital expenditure program by themselves. Their rate of capital formation simply is not great enough to do this.

"Therefore, it is essential that some other method of financing be developed. Could some sort of mutual beneficial sharing of costs be worked out? Would it be possible and under what circumstances for the electric utilities to own the catenaries with possibly a leaseback arrangement? Would joint use of rights-of-way with multi-purpose catenaries for power transmission be feasible as a means of justifying this expense?" George asked.

"Rate considerations relate directly to the capitalization alternative that is ultimately decided upon. If the electric utilities do share or assume the capital expense of the catenaries, this cost would have to be reflected in the energy price to the railroad. And electric energy rates are pivotal in establishing the feasibility of railway electrification. They must be competitive with other fuels; they must be reasonably consistent between the service areas the railway traverses; single billing will have to be provided; and there must be assurance of contractural stability," George said.

The railroads have indicated a willingness to work with the utilities, and this cooperation on capitalization and rates will be essential. An example of the cooperation is the task force study of possible electrification of the Penn Central between New York and Cleveland, Ohio. The task force from the Committee on Railroad Electrification of the Edison Electric Institute worked with representatives of the railroad (then New York Central). Summary of the conclusions was presented to the

Arizona meeting by E. B. Shew, chairman EEI task force, and assistant to vice-president, research and development, Philadelphia Electric Co.

—"There are no insurmountable engineering problems associated with the use of commercial frequency electricity for traction purposes.

—"All necessary equipment for such a system is either in general use now or is readily available.

—"There will be no adverse effects on railroad or common carrier communication and/or signal systems or on the utilities' power supply facilities through the use of a properly designed system.

—"Although a nominal system voltage of 25 kv was chosen as the basis for this study, it appears that even higher system voltages are realistic and may be desirable.

"The characteristics of this type of load are compatible with modern electric power systems. Investigations indicate phase and voltage unbalance to be acceptable and no difficulty is anticipated from harmonics produced in the locomotive or from inductive or radio interference," Shew said.

For the study, 25 kv, 60 Hz single phase AC was selected for the overhead wire system. Some studies indicate even higher voltages, such as 40 or 50 kv might be more economical. However clearances in tunnels, terminals and under bridges on the existing system indicated that it might be necessary to use 12.5 kv instead of 25 kv. The catenary would have to be equipped with suitable automatic throw-over units at selected insulating breaks in the contact wire system.

EEI hired a consulting engineer firm to prepare designs and cost estimates for the overhead wire systems for the New York-Cleveland route. "It is estimated that a two-wire constant tension catenary system, supported on unguyed weathering steel poles in the main and using an average manhour rate of $10 would cost in the order of $40,000 per mile.

"Based on electric utility experience, it appears that the use of wood poles or fibre glass structures would have an economic advantage over the self-supporting steel structures. This may result in a substantial reduction in capital requirements. The consultant's report indicates that for a very small increase in initial cost (less than 1%), the catenary system could be made adequate for operation at 150 mph rather than 100 mph. The wayside substations, both switching and transforming, are estimated to cost an average of $9500 per mile.

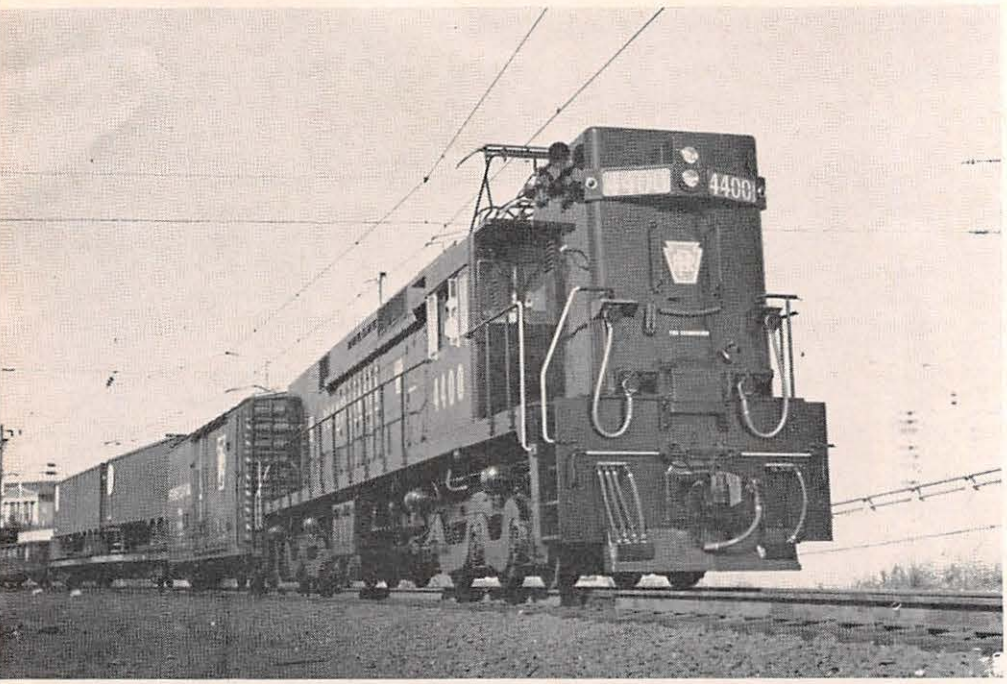
"It was early realized that two power systems, or even parts of the same system, should not be connected through the catenary due to differences in phase angle forcing power to flow from one system to another over railroad facilities. This led the EEI task force to suggest the center feed system whereby the catenary is sectionalized at each supply substation and at the midpoint between; the latter is normally open but can be closed on failure of an adjacent supply. In this event, transformers either side of the failed supply will carry the load in the section added by closing the midpoint sectionalizing switch," Shew said.

Also, a study was made by electric utility companies that operate adjacent to the Pennsylvania's (now Penn Central) electrification from New York to Washington, and Philadelphia to Harrisburg, Pa. Present traction power is 11 kv, 25 Hz and the study was made to consider feasibility of converting to commercial frequency.

"The study indicates it is feasible to supply power to the railroad catenary system at 25 kv, 60 Hz at 24 supply stations from power companies 60 Hz lines of 115 kv or higher. The average spacing between supply points would be 20 miles assuming a 10% normal voltage drop from the supply point to the pantograph at the end of a section. The proposed system would also require 29 switching stations," reports W. E. Kelley, senior electrical engineer-equipment, PC.

Also making electrification studies are the Southern Pacific and the Union Pacific. SP has studied the possibilities of electrifying its mainline from Colton, Calif., to Yuma, Ariz. UP made studies with Ohio Brass Co., in 1962 on electrifying its mainline from Omaha to Neb., to Ogden, Utah, or portions of the line. A more recent investigation by UP covers its heavy-traffic mainline from North Platte, Neb., to Green River, Wyo. John C. Kenefick, executive vice-president, said that electrification holds great promise for the future because of the high speeds and controls which will be necessary.

FREIGHT . . .



RECTIFIER LOCOMOTIVES convert 11 kv, 25 Hz to DC for traction motors.

PASSENGER . . .

METROLINERS travel up to 125 mph between

In 1969, the Muskingum Electric began operation near Zanesville, Ohio. This 15-mile completely automated coal hauling line operates on 25 kv, 60 Hz AC traction power. "The economic feasibility of mainline electrification is becoming increasingly attractive as higher traffic densities develop under the progressive new mission envisioned by American railroads to meet the improved service and higher traffic loads which follow," explains O. F. Vea, general manager, locomotive department, General Electric Co. GE supplied the locomotives, controls to achieve complete automation and power supply equipment for the Muskingum Electric.

As noted in the table, two transit lines, now under construction are located at San Francisco and Washington, D.C. Both will use traction power distributed by third rail. Long Island is now adding 15 miles of electrification.

At this point in time, the future of electrification looks good because of improving technology, such as using standard 60 Hz frequency which eliminates conversion to another frequency. "Also, at the higher voltage—25 kv or 50 kv—the installation of catenary is less costly, and the smaller number of large substations results in a lower dollar investment per kva," reports W. R. Tackaberry, vice-president, power transmission and distribution sales, GE.

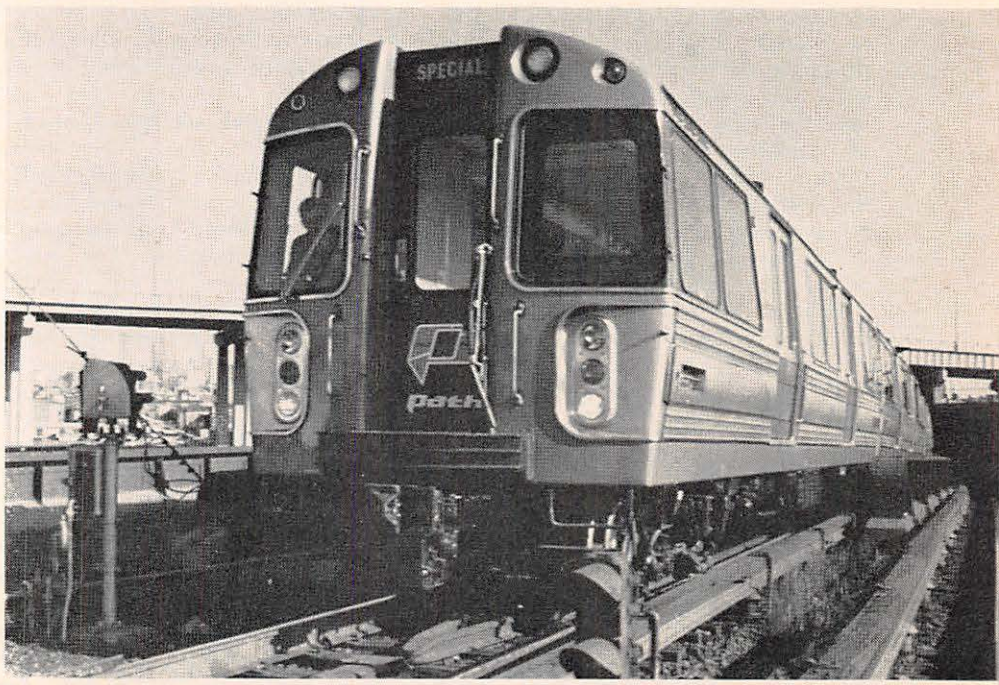
From studies GE has made, Vea says "we believe that about 10% of the railroad trackage involving some 40% of the nation's tonnage could well be above the break-even point in costs if electrified."

ELECTRIFICATION HITS 2500-MILE MARK

System	Location	Route Miles	Propulsion Power
Bay Area Rapid Transit District	San Francisco, Calif. (under construction)	75	1,000 volts DC
Chicago, South Shore & South Bend	Chicago-South Bend, Ind.	76	1,500 volts DC
Chicago Transit Authority	Chicago, Ill.	89	600 volts DC
Cleveland Transit Authority	Cleveland, Ohio	20	650 volts DC
Erie Lackawanna	Hoboken-Dover, N.J.	80	3,000 volts DC
Illinois Central	Chicago-Richton, Ill.	37	1,500 volts DC
Long Island	New York-Mineola, N.Y.	150	600 volts DC
Massachusetts Bay Transportation Authority	Boston, Mass.	65	600 volts DC
Milwaukee Road	Avery-Harlowton, Mont.		
	E. Portal-Tacoma, Seattle, Wash.	670	3,000 volts DC
Muskingum Electric	Zanesville, Ohio	15	25 kv, 60 Hz AC
New York City Transit Authority	New York, N.Y.	251	600 volts DC
Penn Central	New Haven-Washington, D.C.		
	Philadelphia-Harrisburg, Pa.	762	11 kv, 25 Hz AC
	New York-Harmon-White Plains	69	600 volts DC
Philadelphia Transportation Co.	Philadelphia, Pa.	27	600 volts DC
Port Authority Trans-Hudson Corp.	New York-Newark, N.J.	14	600 volts DC
Port Authority Transit Corp.	Philadelphia-Lindenwold, N.J.	15	650 volts DC
Reading	Philadelphia, Pa.	88	12 kv, 25 Hz AC
Washington Metropolitan Area Transit Authority	Washington, D.C. (under construction)	97	600 volts DC

TRANSIT . . .

New York and Washington.



RAPID TRANSIT line uses 600 volts DC from third rail for propulsion current.

C&S Section outlines signal principles

Committee on interlocking, traffic control and block signals developed basic principles for electronic controls for signal systems; presented herewith:

There are two classes of electronic equipment employed in railway signaling: signal control circuits which are directly concerned with safety and reliability; communication circuits such as CTC and supervisory control which are concerned with reliability only.

There is a tendency when a new technology invades a field, such as electronics have invaded railway signaling, to establish specific standards, guidelines, techniques etc., which must be adhered to. This tends to impede progress as there is frequently more than one way to achieve a desired end. This is particularly true as technological state-of-art advances. Specific details of circuit configuration or design should not be imposed as a part of the requisites. What must be done is to adequately define the desired result in such a fashion that it may be determined whether an equipment performs in a failsafe and reliable manner.

The term failsafe is enjoying increased usage in aerospace and other industries. The meaning, however, is not the same as that which has become traditional in the railway signaling industry. The Communication & Signal Section, AAR, has defined "Failsafe" as follows: "Failsafe—a term used to designate a railway signal design principle, the object of which is to eliminate the hazardous effects of a failure of a component or system."

In electronic control system design the following supplements to this definition should be considered:

All possible modes of component failure must be identified.

It must be acknowledged that any or all of the possible failures will one day be encountered.

Equipment design must be such that any single, independent, component failure results in a safe condition and it changes the operation of the equipment so the failure is evident.

Component failures which are not independent, that is, those failures which in turn always cause others, should be considered in combination as a single failure.

Note that the above definition of failsafe may be applied at either the circuit or system level. As applied at the circuit level the word component refers to relays, resistors, transistors and the like. When applied at the system level the word component refers instead to the circuit arrangements which combine to form the system, It should also be noted that while redundancy can increase system reliability it cannot eliminate the hazardous effects of a failure and therefore cannot provide failsafe operation.

For the purpose of safe operation it is felt that the following types of electronic component failures must be considered possible, and the design must be such that the unit will not fail in an unsafe manner when such failures occur.

Resistors, capacitors, inductors, and transformer windings can fail in an open or shorted condition or can change value.

Capacitors can develop high leakage and inductors can develop lower Q.

Semi-conductors can fail in an open or shorted condition between any two or more terminals. Semi-conductors can also develop an abnormal resistance between any two or more terminals. Transistors can change in gain.

Wire is considered to fail by opening or short circuiting to other wires or ground. Wire connections can develop high resistance.

Relay contacts can fail to make contact, can develop high contact resistance or weld closed.

Other components or other failures not mentioned above should be considered.

Environmental conditions must be considered.

The selection of unmodulated or modulated carriers to control vital signal functions should be based upon environmental conditions. The use of modulated carrier is an acceptable method to reduce interference.

Where filters are employed in railway signaling for carrier discrimination, and where reception of a carrier other than the one intended, either in the presence or absence of the one intended, could result in a false and unsafe signal, the filter design must take into account failures and produce a safe failure. In addition, interfering signals if strong enough in strength can over-ride the filter.

Where gain (sensitivity) controls are employed in such a fashion that increased gain may produce an unsafe condition, the circuit must be arranged such that any failure will not produce increased gain.

CTC CONTROLS require safety features.

Adjustment for frequency and code rate where provided should be designed that misadjustment cannot produce an unsafe condition (e.g., a less restrictive code rate).

Amplifiers which have gain greater than unity can produce sustained oscillation if an inadvertent feedback path should occur. The design must assure that such oscillation cannot produce an unsafe condition.

Overlapping track circuits can be separated by carrier frequency if failsafe band pass filters are used for carrier frequency detection. If failsafe band pass filters are not used, distinctive modulation and failsafe demodulation techniques must be employed for each such track circuit. In any case, harmonics and mixing of frequencies, including external frequencies, must be considered in the system design to prevent any unsafe condition.

The effect of input voltage level variation shall not cause an unsafe condition.

Note that the foregoing guidelines do not in any way preclude derivation of energy for vital relay drive by means other than transformer coupling. Also, the guidelines do not preclude the connection of one vital relay coil terminal to system energy so long as so doing cannot in conjunction with component failure produce an unsafe condition.

It should also be noted that the foregoing guidelines do not specifically preclude the use of a circuit common which is purposely connected to vehicle frame or earth ground so long as the presence or absence of the ground connection cannot cause an unsafe condition. Such a connection, in fact, is preferred in electronic systems for noise control purposes. Where employed such a connection should be made at one point only and should be arranged so as not to carry signal current.

ALTERNATE GUIDELINES may be desirable to increase signal safety.

Advancing technology can aid signal design

R. C. Hoyler, advisory engineer, vehicle systems projects, Westinghouse Electric Corp., wants signaling to take advantage of advance technology; comments herewith:

Communication & Signal Section, AAR report entitled "Signal Principles Defined" contains recommendations for the design of vital equipment which are not sufficiently complete or inclusive to provide adequate safety consistent with the traditional concept of fail safety. At the same time, these recommendations do not allow all phases of technology for providing safety which can be achieved easily today, in spite of the recognized fact that such provisions are desirable.

In considering failure modes, many possible component failures are listed which, in general, can and will occur. But it is possible to so construct a resistor, for example, from a given length of tungsten wire that, because of the known physical properties of the material and the method of construction, the resistor cannot decrease in resistance under any known failure mode. It is possible by physical construction to wind a transformer on an insulating ferrite core such that it cannot short circuit from primary to secondary. Such procedures are based on invariant physical properties, in the same way that the safe operation of a vital relay depends on the constant presence of the force of gravity, the non weldability of carbon, and the strength of its physical construction.

It is known that under all normal conditions the resistivity of a conductor has a defined value for a given length, area, purity and temperature. Likewise, an insulator cannot become a conductor, brass cannot become magnetic, a random function cannot continuously produce an ordered function, etc. Similarly, construction techniques such as physical separation, electrical separation (ground planes), and encapsulation can be employed to prevent short circuits between wires. Good quality control is required in all cases to assure that these techniques are successfully achieved.

Basing the safety of life and property on the assumption that only a single failure can occur is really unacceptable. Any failure or combination of failures which can exist, whether related or not, should cause the system to revert to a condition known to be safe, regardless of whether the failure is otherwise made evident or not. The alarming of a single failure is insufficient if before anything can be done about this failure an independent failure causes an unsafe condition. In modern complex systems especially, the large number of components increases the probability that more than one independent failure will occur within a short period of time. The question of reliability and gradual performance degradation under failure conditions should be taken into account for MTBF and system performance, but it should in no way compromise the safety. Correlated failures, of course, must be considered as single failures, and these include such things as effects of lightning, loss of power supply regulation, damage to adjacent track circuits by dragging equipment, etc.

The article states that "overlapping track circuits can be separated by carrier frequency . . .". This is insufficient because the simple case of dragging equipment on a welded rail system can cause normally remote track circuits to become overlapping, thus possibly causing unsafe conditions unless normal attenuation is sufficient to provide protection under all conditions.

The use of a modulated carrier to reduce interference is useful only under certain conditions. In the case of wideband noise, no advantage is gained by the use of a modulated carrier because the received noise is a function of bandwidth only, regardless of the carrier frequency. If an interfering signal is present, such as 60Hz or its harmonics, then frequency translation can remove the transmitted signal from the extraneous signal. In the case of vital signals, it is inadvisable to choose the format of the signal (code rates, code words, etc.) such that any extraneous source can cause it to appear improperly at any level of the system, whether it be modulated or not.

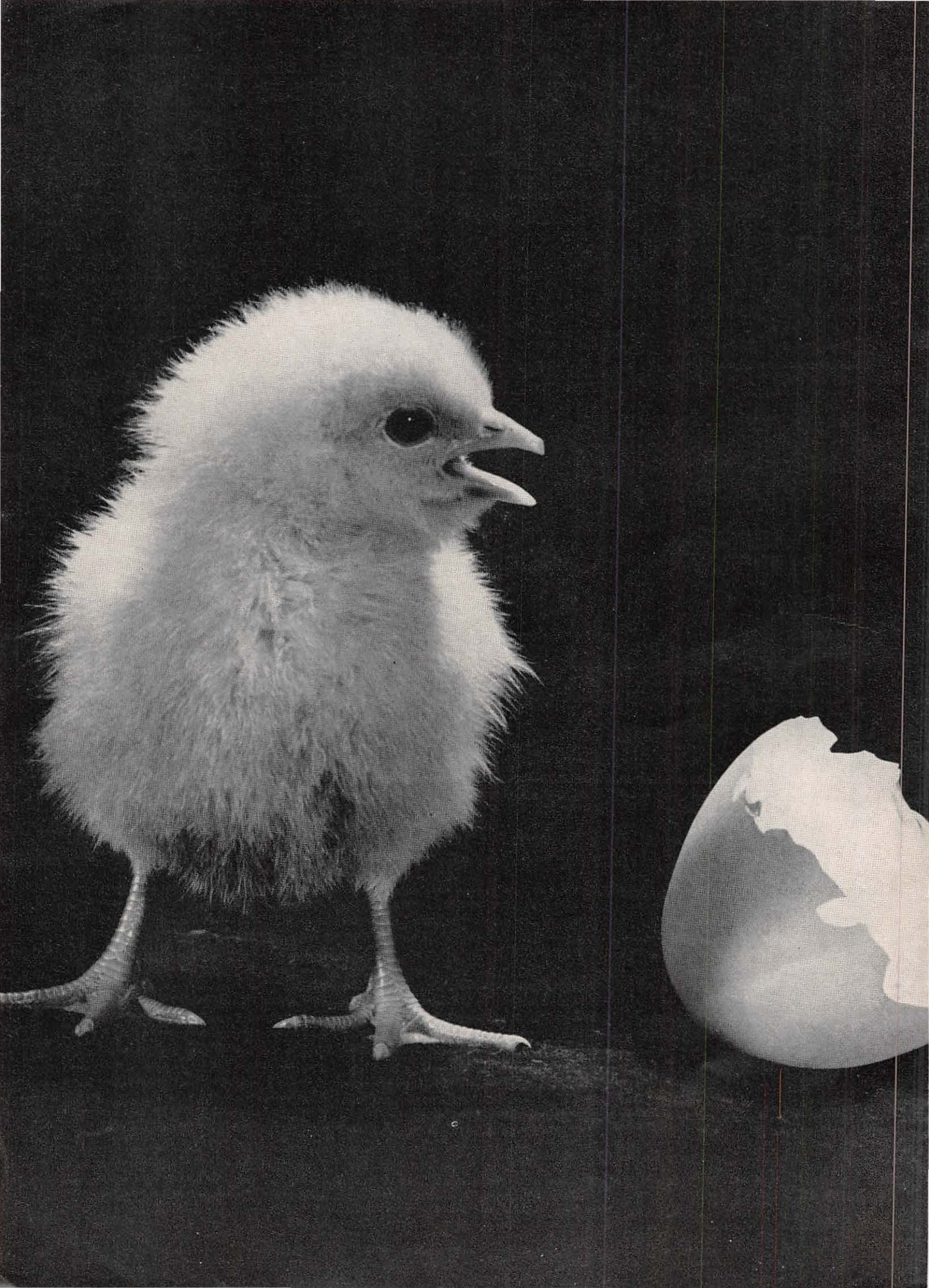
A much closer look should be given to this entire problem, and guidelines should be developed to ensure that modern systems are fully as safe as the state of the art allows. It is suggested that an alternate set of guidelines be established for the industry for maintaining safety at a higher level than is provided by the proposed guidelines. At least, the following modifications should be made to the guidelines as they presently stand:

(1) Provide for the use of "vital" resistors, "vital" transformers, and other vital elements which can be constructed to have a known unidirectional mode of failure.

(2) Require safety under all the independent correlated and combinational modes of failure as necessary to eliminate all hazardous effects of failures.

(3) Suggest construction techniques available for achieving safety, to be used as a guide rather than a specification.

It should be realized that it is equally as possible to build a non-failsafe system from failsafe components as it is to build a failsafe system from non-failsafe components. Therefore, since the best that is done should be the best that can be done, the guidelines should not be defined in terms of "safe enough" or "fairly failsafe" but should allow all advances in the state of the art through the use of purely functional specifications, thereby achieving the desired result with the greatest possible safety.



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Studies reveal benefits of ACI

Cost-benefit analyses show that ACI can produce net savings.

So far, most railroads are finding that implementation of automatic car identification is all or greatly outgo for labeling freight cars. A few have ACI scanners in service—some 30 were installed during 1969—and estimates are that about 200 will be ordered this year. For some, they are waiting until the interchange fleet is labeled. But many railroads are realising that it takes time to install, debug, program and implement ACI systems. These roads are well along in planning and will be ready when the fleet is labeled, due date now set for June 1, 1970.

The economic justification for ACI systems lies primarily in three basic areas: (a) direct labor savings: (b) indirect labor savings as a result of eliminating open car records; and (c) timely, accurate and complete collection of data for use in improving control of equipment.

Studies by several roads reveal that direct labor savings will be available from the use of ACI in five major areas.

(1) ACI will be used at the entrance and exits to yards to verify the cars and position in train. For the yard forces, this will permit the entrance to receiving tracks and departures to be made at normal operating speeds. This information will flow directly to the users as verified information. Direct labor savings are possible by elimination of inbound and outbound manual checking. The normal operations speeds will reduce initial and final terminal delay payments to road crews. With ACI verifying the cars as they are pulled from classification yards, the speed can be increased from 5 to 15 mph. This will reduce switch engine time for each track pulled and can result in actual elimination of yard crews.

(2) ACI will replace the wayside TV scanning systems that are currently used for visual verification of cars. Discontinuance of TV systems and clerical personnel used to observe and record car movements will more than offset the expense of ACI systems.

(3) ACI will be used to make the complete record for cars and locomotives moving over joint track arrangements. This will eliminate the need for personnel to maintain such records as the input would be mechanically processed for joint facility billing.

(4) ACI will be used to verify and print out necessary information concerning interchange of cars. This will replace clerical personnel on the two roads involved as the ACI input would accurately serve both receiving and delivering carriers.

(5) ACI can be used for billing purposes where high volume of cars of same commodity are billed. Car numbers and weight from coupled-in-motion scales can be passed directly to computer systems for preparation of waybills completely void of manual effort. Clerical personnel used in the weighing and billing processes can be eliminated.

Open car records represent an indirect labor saving that can result from the application of ACI. While most roads figure that it costs $10 to close an open car record, one road, which made a very detailed time study on such work found that it cost them only $2.28 per record. However, it was admitted that this figure omitted telephone calls to agents or other railroads, plus any mailing charges to obtain missing records or copies of waybills. Even so, this road determined from a study of a major interchange point that installation of ACI would pay for itself in 2.5 years due to savings in eliminating open car records and penalty per diem claims through this interchange.

One large railroad made a study for the installation of ACI systems at 27 locations. Annual costs were calculated including scanner lease-maintenance expenses. One time costs included site preparation, signal and communications facilities required and labeling of the road's own cars. Also considered a one-time cost was purchase of the ACI scanners and associated equipment. While costs exceeded savings by $180,000 the first year, savings the second and third years would total $660,000. Thereafter, savings would total $825,000 per year. These are tangible labor savings only.

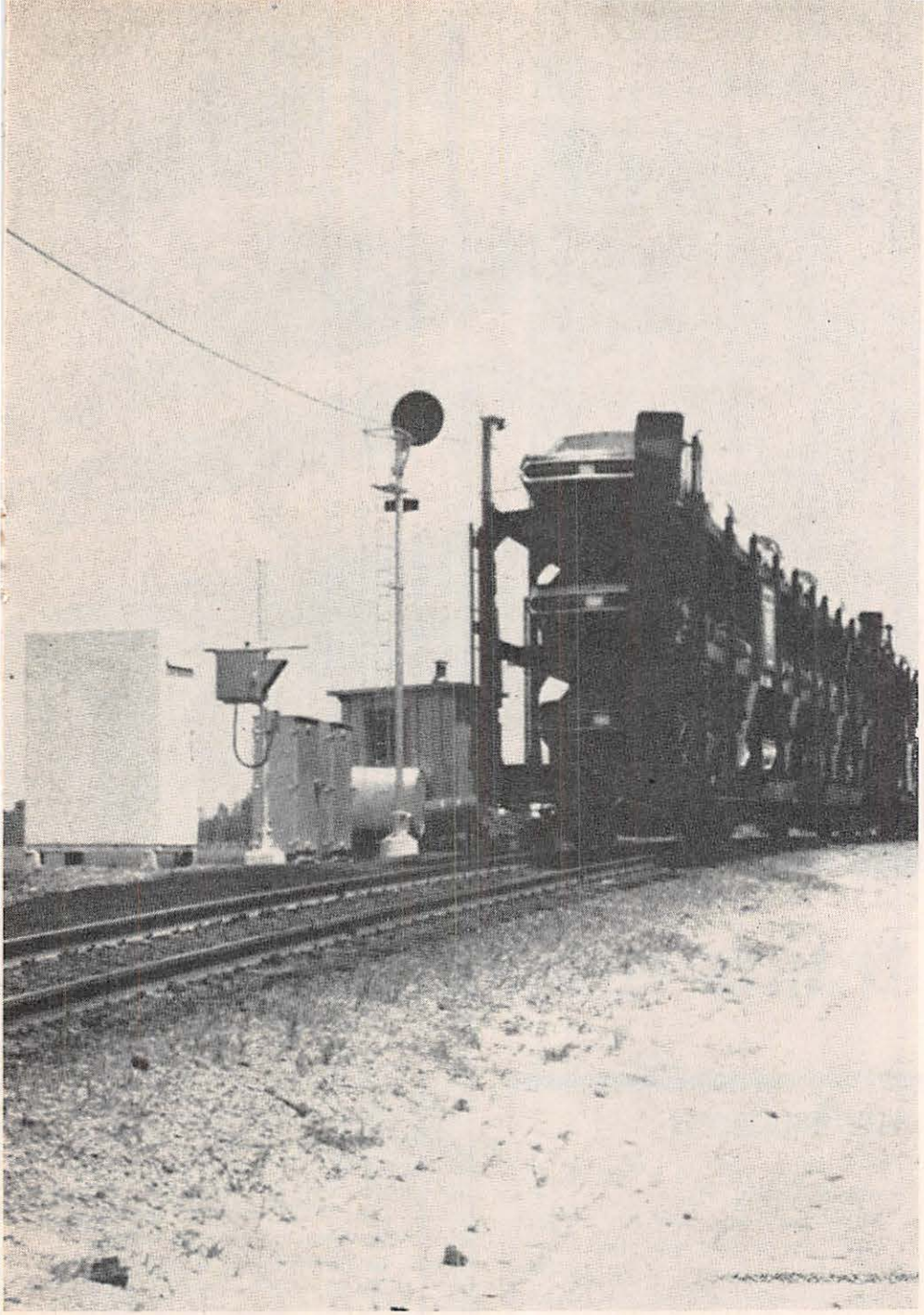
Other tangible savings developed by the road include a 25% reduction of open car records, IBM machine rental, road crew initial and final terminal delay, relief from penalty clerical payment due to shortage of personnel, and per diem from mishandled cars. These tangible savings totaled $290,000 an-

MANAGEMENT INFORMATION

Automatic car identification is, said by some, at a crucial time in its development. Labeling of freight cars in the interchange fleet is progressing, and is due for completion by June 1, 1970. However, labeling the cars will not bring immediate benefits. Railroads must have ACI systems in service, even to get the minimal returns of accurate identification of cars.

While almost every railroad is planning for installation of ACI systems, very few are now reaping the financial rewards of operating systems. As has been stressed in previous articles in this magazine (Jan. 1970 page 32 and Feb. 1970 page 22), analyses of operations must be carried out to determine where ACI can be useful and also to determine the economic and operational benefits.

Now is the time to start ordering scanners and associated equipment if roads are going to be anywhere near ready to take advantage of the completely labeled car fleet. One manufacturer reports production capacity of 50 scanners per month, but orders averaging 12 per month. To one rail observer, it is like Christmas shopping. Everyone will wait until the last minute, then complain because he can't get prompt delivery.



ACI SCANNER at hump crest can check cars into class yard and route them.

COMPUTER can handle inputs from several ACI scanners for data processing.

nually, and would continue.

The biggest benefit from ACI is that of tying it in with a computer, particularly a railroad's central computer facility so that the accuracy of ACI can be matched with waybill information.

"ACI will have an appreciable effect on Southern when it is perfected. We plan to use it eventually on both road and yard and will interface the information received through ACI with waybill information obtained through LDX (Long-Distance Xerography transmission of waybill data to the Atlanta computer center) to produce hump lists, interchange reports, car accounting aids, yard inventory, car movement records and train movement records. We expect ACI to not only improve the accuracy of reporting, but also the the efficiency," said W. H. Moore, vice-president operations, Southern.

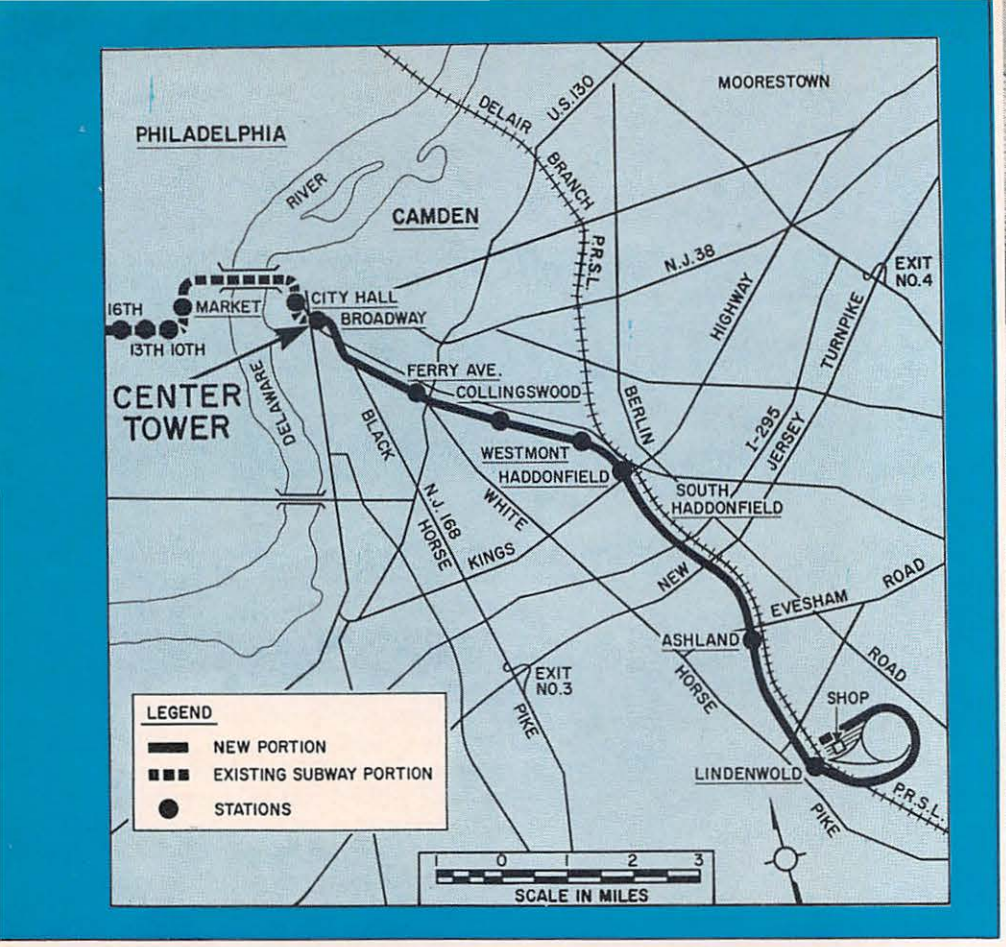
J. L. Jones, vice-president information services, Southern, points up the importance of tving ACI with the computer. "ACI will be primarily a supplement to our current data capturing systems because all you get from ACI is car initial and number and direction, while there are numerous other things you need to know about a car, such as where it is headed and whether or not it is loaded."

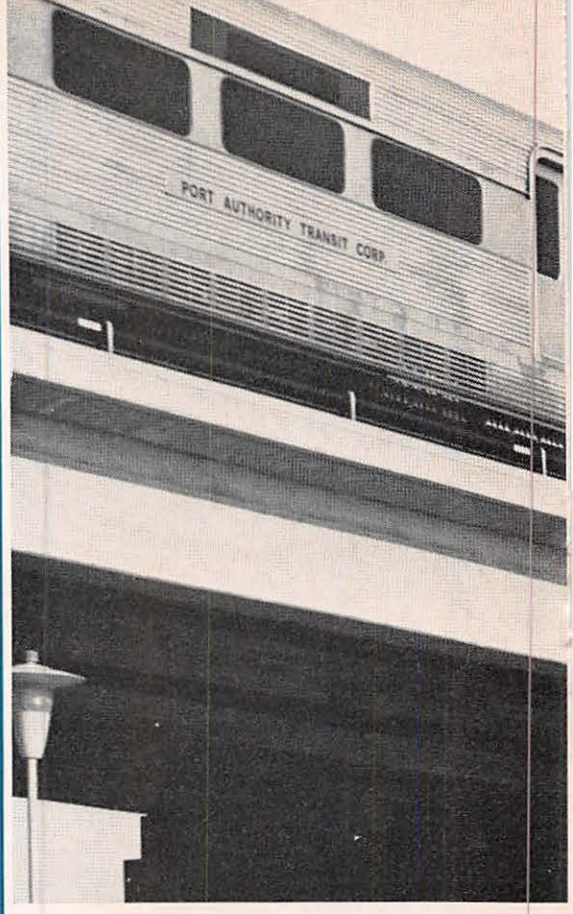
One railroad made a detailed study of what can be accomplished by the use of ACI at a major yard which classifies 2800 cars daily (single car count). The clerical staff has 10 assignments per shift, and the annual cost amounts to $300,000. Seven ACI scanners would be located at strategic points with direct connections to a central computer. with output devices located within the local yard office. Four ACI scanners would be at entrances and exits of the yard where they would cover interchange as well as inbound and outbound trains. These scanners would permit a 30% reduction in force amounting to $90,000 annually.

Two ACI scanners would be located on leads between the classification and departure yards. Data collected by these scanners would eliminate two outbound car checkers per shift. One ACI scanner located on the hump would be interfaced with the yard switching system.

In this study, seven ACI scanners would be used at an initial expense of $101,500. The one-time communications and programming expense would amount to $45,000. Use of the ACI equipment would permit a 60% reduction in clerical costs, amounting to $180,000 annual savings. The net first year savings would be $33,500. Thereafter, savings would total $180,000.

One rail officer involved in ACI cost-benefit analysis maintains that the original justification for ACI remains.





PATCO TRAINS run on 3-minute headways

Rapid transit trains run automatically

MANAGEMENT INFORMATION

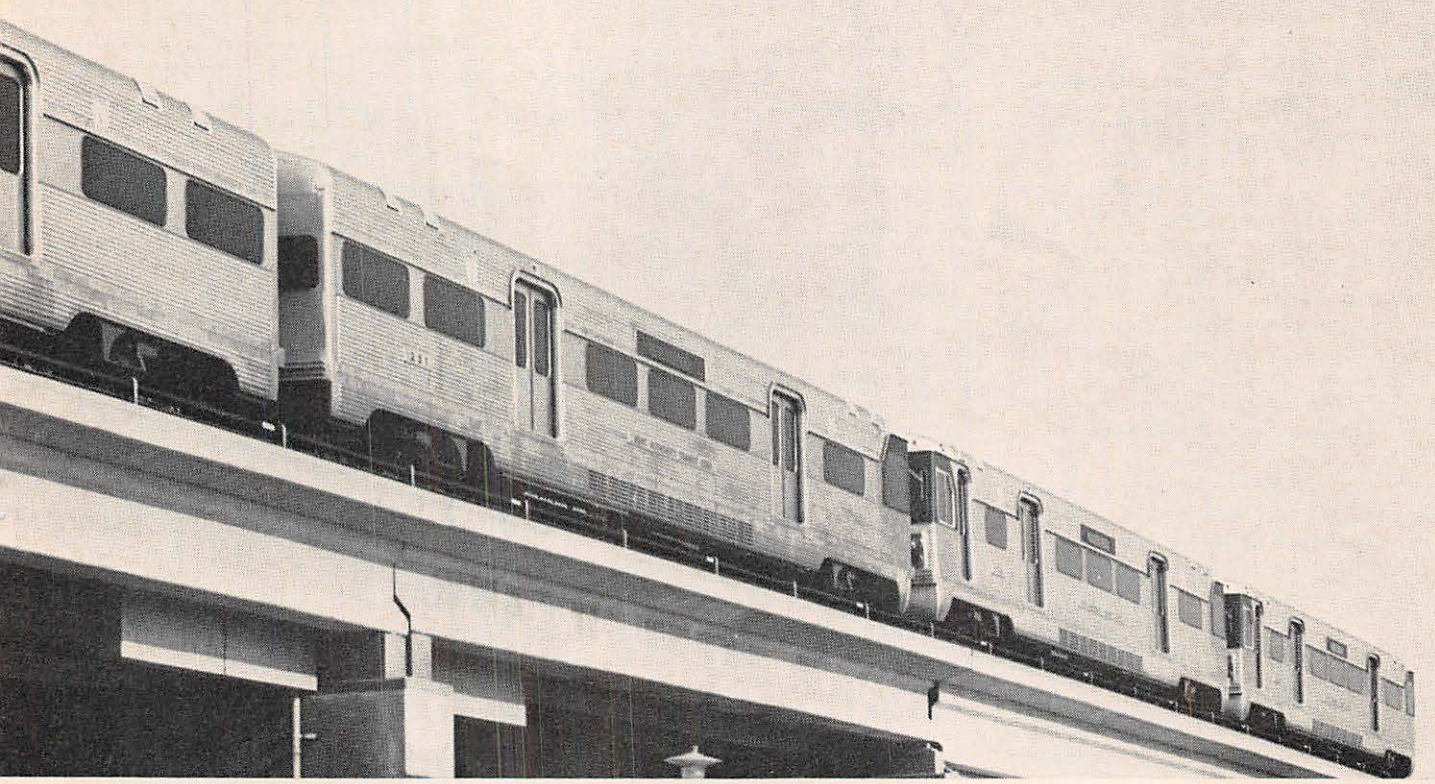
To handle upwards of 30,000 commuters daily, a Philadelphia area transit line has found that automatic train operation and centralized control provide a successful operation. Port Authority Transit Corp., operates a 14.5-mile, double-track line from 16th and Locust Streets in down town Philadelphia to Lindenwold, N.J., via Camden.

PATCO runs expresses mixed with locals during rush hours to provide headways down to three minutes. An attendant operates door controls and "start" button to start the train. After the "start" button is pressed (with doors closed—an interlock prevents starting with doors open), the train runs automatically to the next station where it is brought to a stop near the center of the platform.

Supervisory control of ten interlockings, the power system for traction current and three communications systems are all controlled from Center Tower at Broadway, Camden. To communicate with passengers in stations, a public address system was provided. Also tied in with the Trainphone radio system on trains, announcements can be made to passengers riding the trains. Dispatcher-to-train attendants' communication is carried out via the Trainphone radio system. An automatic dial telephone system provides service between Center Tower, all power substations, passenger stations and repair shops.

It's only a 23-minute ride over the 14.5 miles from Lindenwold, N.J., to 16th and Locust streets in downtown Philadelphia via Port Authority Transit Corp.'s new double track rapid transit line. PATCO runs expresses mixed with locals during rush hours to provide headways down to three minutes. Automatic train operation enables the trains to be operated at maximum performance by one attendant. He operates door controls, a "start" button to start the train, and a "station bypass" button for directing express trains to skip stations.

The line was opened for service to Camden, N.J., Jan. 4, 1969 and full service to Philadelphia Feb. 15, 1969. ATO has been functioning satisfactorily for about one year. Three major control systems were installed: (1) track circuits, signaling and interlockings; (2) car-carried cab signal and ATO controls; and (3) communications facilities including train phones, radio, dial telephones and supervisory control of electrical power substations. Equipment for systems (1) and (3) and the cab signal portion of (2) was furnished by the Signal & Communications division of Westinghouse Air Brake Co. Car-carried equipment for automatic train



during rush hour on 14.5-mile, double-track line between Lindenwold, N.J. and Philadelphia.

to serve Philadelphia area

operation was furnished by General Electric Co.

The rapid transit line is completely new between Broadway (Camden, N.J.) and Lindenwold stations (10.5 miles) and uses the existing line between 16th street (Philadelphia) and Broadway station (4 miles). This double-track automatic block rapid transit system is right hand running with terminal turnbacks at each end and with intermediate turnbacks, at Ferry avenue and at Haddonfield, for local train operation.

For train detection in the new area (Broadway to Lindenwold stations), 100 Hz AC track circuits are used. For speed commands to the train, 100 Hz coded cab signal energy is superimposed on the AC track circuits. In the existing area (16th street to Broadway), 100 Hz coded cab signal energy is superimposed on the existing 60 Hz AC track circuits. The cab signal energy is coded at the following rates (pulses per minute): 420 for 75 mph control, 270 for 40 mph control, 180 for 30 mph control, 120 for 20 mph control, and 75 for 0 mph or stop control. This 75 code rate initiates a full service brake application. Lack of cab signal energy will initiate an emergency brake application.

To provide for safe and efficient switching of trains in normal operation and to provide run-around moves in the event of a disabled train, track work, etc., there are 10 interlockings. Six plants operate automatically under normal conditions and the remaining four are used for emergency or abnormal conditions. All interlockings can be controlled from Center Tower by supervisory control. Wayside signals are installed only at interlockings.

The turnback interlockings at Ferry avenue and Haddonfield are automatically set, using Identra train identification equipment to provide automatic routing into the tail tracks for turnback moves. The Identra system consists of a permanently-mounted, train-carried, inert tuned coil and wayside coils and equipment. The train coil, carried underneath the lead car is connected to a switch at the attendant's position by a tuned cable. The switch permits the choice of frequencies by changing the capacitance in the tuned circuit. Thus, a train can be identified by a specific frequency. Local trains carrying the Identra coils will automatically route themselves into the turnback track. After changing ends and receiving a starting light indication and cab signals, the attendant will press the start button. This will automatically move the train onto the mainline for return runs to Philadelphia immediately after an express train has passed.

With a train standing in a station, the attendant operates the door controls. After he closes the doors and presses the start button, the train, under ATO proceeds to the next station operating at maximum safe speed. If it is an express and should skip the next station, the attendant presses the "station bypass" button as the train approaches the station. This will cancel the station-stopping portion of the ATO function. Automatic station stopping is achieved through the use of energized wayside trigger coils placed at measured distances preceding station platforms. Two trigger coils are used if trains approach stations at 75 mph to improve stopping accuracy.

Included in the car-carried equipment is a speed-distance regulator to control car speed in accordance with received cab signals and to make automatic positioned stops at passenger stations. The ATO interface circuitry receives contact closures indicating maximum speed from the cab signal system. A priority interlock ladder in

the cab signal circuitry (control circuit arrangement) assures response only to the most restrictive signal aspect. The output of this circuit establishes running speed and overspeed references.

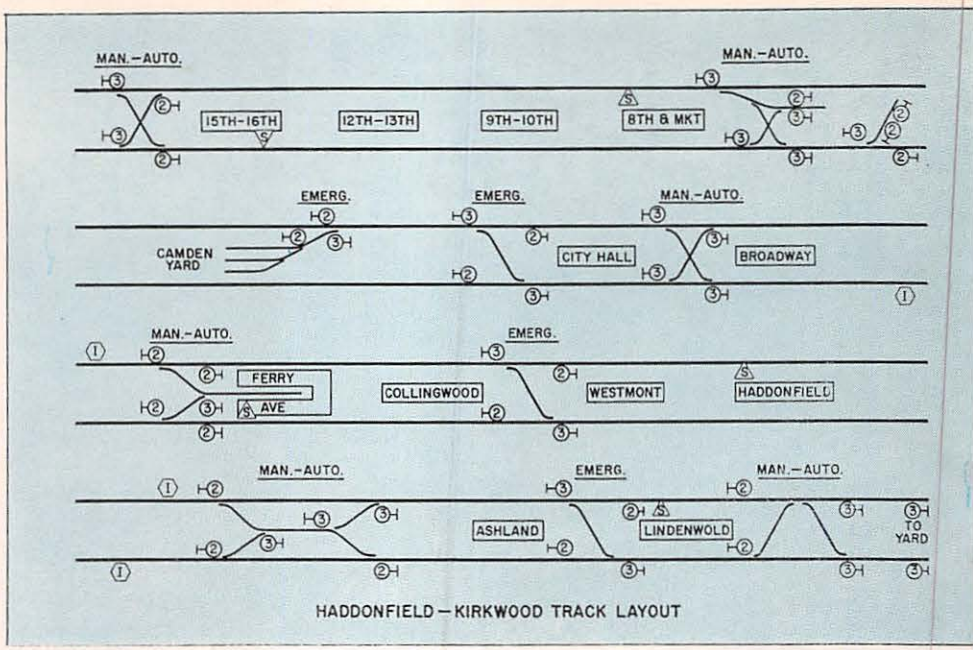
The speed regulation function provides continuous closed-loop modulation control utilizing the maximum performance capability of the propulsion equipment, within the safety requirements set by the cab signal system, and while maintaining desired passenger comfort.

The speed regulation function compares the running speed reference with actual car speed to derive an error signal. The error signal is applied to the motoring and braking translators for conversion to suitable control signals that actuate the propulsion and braking systems to control train speed to within plus or minus 2 mph of the called-for value. When the cab signal aspect changes either upwards or downwards, the running speed reference is "ramped" by an integrating amplifier to provide for smooth transition between car speeds. The ramp rate is set for compatibility with car dynamics.

By the combination of closed-loop modulation control and ramped changes in the speed reference, speed changes requiring a shift from power to brake, or vice versa, are made within the limits of the rate of change (jerk) capabilities of the propulsion and braking systems. When accelerating in limited speed areas, the speed regulation function uses the maximum propulsion rate until the error signal approaches zero, then acceleration rate is reduced gradually to achieve the regulated speed smoothly and without overshoot.

The positioned stop function is accomplished by regulating instantaneous train speed in a pre-programmed relationship to distance traveled. Distance is obtained by integrating car speed. Positioned stops are accomplished from 75 or 40 mph speed zones in distances of 2,260 and 825 ft, respectively. These distances are modified somewhat by a feature called "train length indexing" which adjusts stopping distance according to train length to allow the center of the train to always stop near the center of the station. Stopping accuracy is a 40-ft band for this application. Train length varies from single cars up to six-car trains with provision for future eight-car trains.

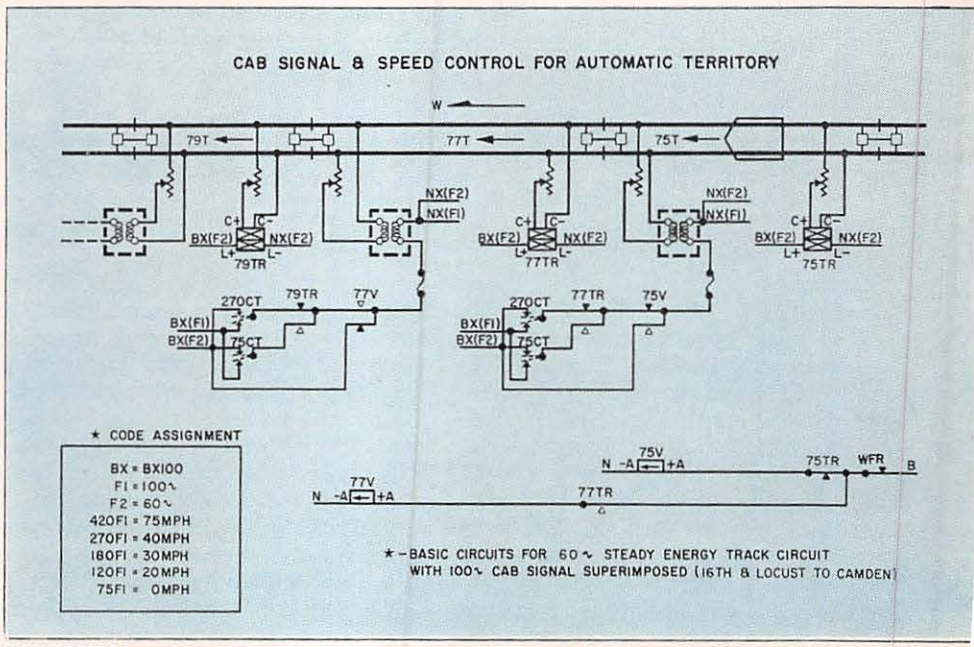
The output of the priority interlock ladder also establishes an overspeed reference which is 3 mph above the running speed reference. Overspeed circuitry continually checks that actual car speed is no more than 3 mph above the running speed reference or emergency braking is initiated. This checking for overspeed is unique in that it operates continuously, even during speed changes. During speed changes, the overspeed reference is also ramped and a continuous check is made to assure that the instantaneous overspeed limit is not exceeded.



HADDONFIELD–KIRKWOOD TRACK LAYOUT

IDENTRA UNITS near Ferry Ave. and Haddonfield send locals to tail tracks.

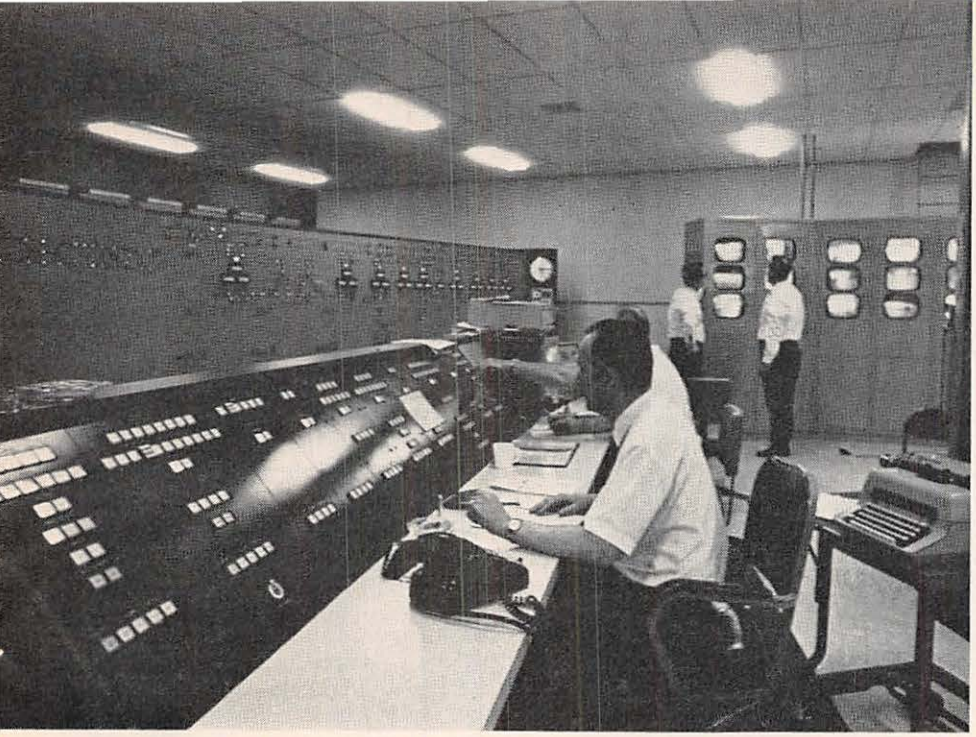
PATCO HAS AUTOMATIC RUNNING WITH



CAB SIGNAL and speed controls are used throughout the system.

The error signal derived by comparing speed references with actual train speeds reaches the propulsion and braking translator as a 0-22 volt signal with 0 volts representing full brake, 11 volts representing coast and 22 volts representing full motoring capability. The propulsion and braking translators convert the 0-22 volts into contact closures for energizing motoring and dynamic braking train lines and to a 0-0.6 amp analog signal for control of the air brakes. Zero amperes is equivalent to full braking while 0.5 amp is equivalent to full brake release.

Accurate and reliable sensing of the rapid transit car speeds is essential for automatic train operation. The basic car speed signal is derived from two independently mounted speed sensors, the outputs of which are continuously cross compared to insure the integrity of the speed signals being received and to select a master signal for input to the speed regulation and overspeed controls. Loss of either of the speed sensor signals or a discrepancy of greater than



DISPATCHING and power control are supervised from Center Tower, Broadway.

SUPERVISORY CONTROLS FROM CAMDEN

5% that persists for more than a normal slip-slide correction time will initiate an emergency brake application.

To provide proper spacing of trains and maintain schedules, clock-driven, automatic train dispatching units with a remotely controlled retard and advance mechanism regulate train departures at five locations along the line: Lindenwold, Haddonfield, Ferry avenue, 8th and Market streets, and 16th street. Passing of prepunched plastic film through the unit turns on starter lights and bell at these train dispatching locations to alert the train attendent.

Trains can be operated manually with or without cab signal controls. When making up trains at Lindenwold yard, for example, operation would be manual without cab signals. For mainline running, trains can be manually operated by the attendant with cab signals and overspeed protection being operative.

The supervisory facility to remotely control and monitor the 10 interlockings and 11 electrical power substations is located at the Broadway substation in Camden, N.J. A desk-type train control console, a separate track diagram panel and a substation remote supervisory control panel are located at this facility on the second floor, called Center Tower.

The train control, pushbutton panel mounted on the desk console, consists of groups of pushbuttons and indicator lamps for each interlocking. Functions that can be controlled or monitored include: switch and signal control; wayside mode- automatic or manual control and indication: mode select- control and indication for turn around patterns; traffic- normal or reverse control; advance or retard control of automatic train dispatcher; control of snow melters; subsystem-in-use indication for digital data system sharing; lamp test- control for console and track diagram panel; alarm acknowledge- pushbutton and indication; and control reset- command for request cancellation. Also located on the console desk is a traingraph recorder, trainphone control panel, dial telephone and public address equipment.

The track diagram panel containing the track layout with appropriate indication lamps, displays five types of indications: track occupancy- normally lit when unoccupied (white light); wayside signals- panel shows either proceed (yellow) or stop (red); switch position- normal or reverse, only one will be illuminated depending on the position of the switch; traffic direction- normal or reverse (white light) only one illuminated to show direction of traffic in each block-solid arrow for normal-hollow arrow for reverse; and start indication- dispatcher confirmation (blue light).

The substation remote supervisory control panel provides individual groups of pushbuttons, lamps and meters to supervise each substation. Point selection pushbuttons are a combination switch and indication used to select the desired point (substation) that is to be controlled. They are divided into four quadrants with lamp separators and four different lamps. The lamps are used to indicate control disagreement, point select answer back and the present status of the remote switch or circuit breaker such as trip or close.

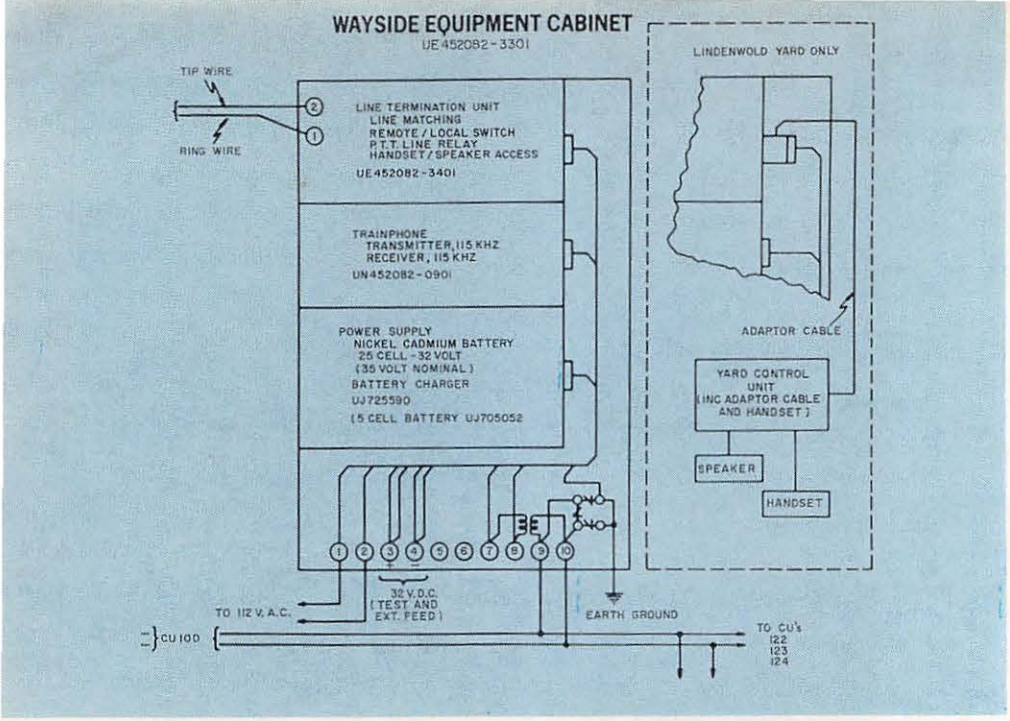
These point select pushbuttons are used for vital controls and the select-check back-execute principle is observed. A control is established first by transmitting a control selection of a particular substation by pressing the point selection pushbutton. If it is a valid control, the chosen point select answer back indication will glow. Only after this lamp is "on" can an execution control be carried out at the substation. Status indications transmitted back to the master station are checked against a command memory relay at the master station. If there is a disagreement between the storage relay and the command memory relay, a control disagreement lamp will blink repeatedly and an audible alarm will sound.

The alarm acknowledge button is pressed to silence the audible alarm and cause the control disagreement lamp to glow steadily. Trip and close commands determine the type of action to be performed at the substation after the point selection has been established. Cancel command is used to correct a mistake in selection. Alarm indications at the substation are transmitted back to the office and displayed by the alarm indication lamp.

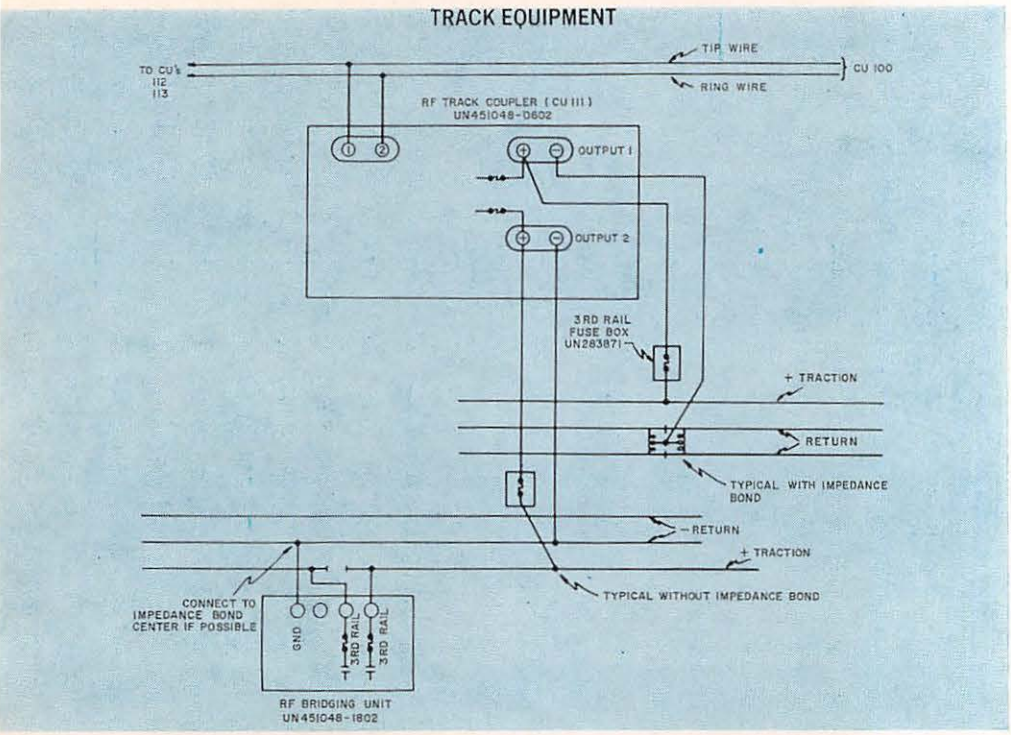
Digital data transmission is achieved through the use of 10 solid-state Flexicode 560 systems and one direct wire system to link the office with the remote stations. These digital data systems control and monitor both the signaling and substation systems. These data transmission systems, provide constant interrogation unless a control is requested, operate at 200 bits per second with 32 bits per frame, and have four security checks. These checks are: complement-every other bit; parity- address must be even number of logical ones; long and short code check (indication monitor check); and check-before-execute procedure for vital supervisory controls.

Communication between the control office and remote stations is accomplished over voice grade circuits. For this application a frequency shift carrier channel is provided which is designed for binary coded data transmission. The center frequencies used are 1,615 Hz and 2,295 Hz.

Various DC voltage and current values are monitored at the substations, transmitted by telemeter equipment and displayed on the power control and model board. To reduce the number of telemetry channels required, some of the voltage values share the same data path and meter. Selector pushbuttons with combination switching and indicators are used to select the desired equipment to be monitored. The value of DC current or voltage is



TRAINPHONE has special controls for Lindenwold yard.



SPECIAL COUPLING used to connect wayside units to track.

sent from the substation to the office over variable frequency tone telemeter equipment. The measured DC value is converted to a telemetering signal frequency for transmission and, at the receiver, the telemeter signal is demodulated to yield a DC output which drives the appropriate meter.

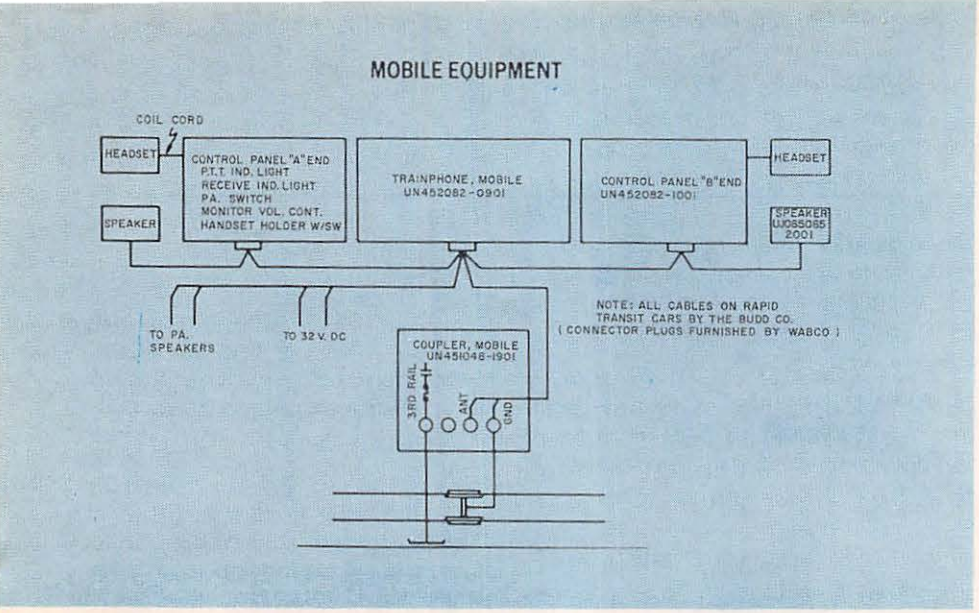
Three independent voice communications systems were installed on the Patco rapid transit line. A Stromberg-Carlson private, fully automatic dial telephone intercommunication system was installed between Center Tower and all power substations, passenger stations, repair shops and wayside locations where maintenance work and/or operational tests could be performed. A second communications system is the Trainphone low frequency simplex carrier current radio system which operates over the 688-volt DC positive third rail power supply for traction current. This radio system allows instant communications between the train dispatcher at Center Tower and any train. The Trainphone radio also includes the public address amplifier for public announcements within the cars by either the train attendant or the central dispatcher. And the third communications system is the passenger station PA system, which provides coverage of each station on an individual basis or collectively from Center Tower. Control by the station agent is also provided, but since stations are unattended, this feature is little used. There is also a priority override to each station system by the Center Tower dispatcher.

The systems approach was taken when designing the communications for the Patco line so that it was possible to combine functions and equipment when and where practical. The one item common to all systems—voice, remote control, supervision and telemetry—is the aerial cable running the length of the Patco line. This cable consists of 25 pair (AWG 19) quads. The number of quads between fixed locations is determined by present requirements plus future expansion capability, and varies between one and six. All voice circuits in the telephone cable are H88 loaded for quality.

The private automatic exchange, series 6 PAX, is located at Center Tower. It is equipped for 80 lines, but wired for 100 lines. At present there are 77 actual lines with 95 telephone instruments in the system. All phones are the type 500 with the majority being wall mounted. Outdoor phones are mounted in lockable weather-proof housings. Western Electric pay-type telephones are used for the passenger "Call-for-Aid" and additional fare collection needs in stations adjacent to fare gates. At Center Tower, the console includes a special phone with four line, hold and headset buttons. When placed in "headset" condition, the normal handset is replaced on hook and a special headset is usable from two positions on the console and three positions on the supervisory panel.

Features in this Patco telephone system are: (1) Executive right-of-way allowing certain telephones the privilege to override a busy condition by pushbutton control. (2) Party line ringing of individual phones when using a common line from field to exchange. (3) Conference service allowing multiple telephones to meet by dialing an assigned number. (4) Rotary hunting permitting incoming call to be switched to next consecutive non-busy number of a group when number called is busy.

Trainphone radio circuitry is fully solid state and is contained within a weather and dust tight aluminum case that is mounted under the attendant's seat. All power transisters, fuses, transformers, plug-in relays, etc., are secured directly to the chassis. Other components are mounted on six plug-in printed circuit boards; two boards each for transmitter, receiver and public address amplifier. All wiring to the unit is through a multi-pin connector.



MOBILE TRAINPHONE has unit to block DC traction current.

The transceiver uses FM modulation with 3 kHz deviation and a carrier frequency of 115 kHz. The radio frequency output is 30 watts while receiver sensitivity is 20 mv minimum and adjustable. The PA amplifier has an output of 25 watts minimum into a 70-volt balanced audio line.

The Trainphone control panel at Center Tower contains zone selection pushbutton switches, self-illuminated upon selection; call/receive and transmit illuminated indicators as part of the special busy-acknowledge pushbutton switch; handset with hang-up switch; speaker and cancel switch. In operation, an incoming call will be heard in the speaker and cause illuminated indication of the associated zone. Selection of the zone will release the call indication and allow push-to-talk signaling to be completed to the selected zone or zones. With the handset off-hook, all audio from the selected zone will be in the handset receiver. Audio from unselected zones will continue to be heard in the speaker at a reduced volume level. Should a call come in which cannot be acknowledged in voice, an optional 1,000 Hz tone may be used by depressing the "busy-acknowledge" switch for the proper zone.

The control panel is connected by cable to a rack mounted equipment assembly containing the relay logic, solid state line amplifier, etc. Operating power for the office equipment is supplied from a 125-volt battery jointly used by other equipment. Battery operation insures continued use during any AC power outage.

At wayside locations in the field, audio and simplex DC signaling enter via the telephone cable to standard 19" rack mounted units. The line termination unit is for terminating the audio telephone circuit and properly interface the audio for receiver output and transmitter microphone input. In addition to the audio circuits, the unit contains the simplex line circuits required for push-to-talk and the reverse transmit/receive simplex indicator line circuits. The unit also has facilities for local control of the waystation.

The Trainphone radio sets are interchangeable between wayside cases and under-seat mountings in transit cars. The third unit at the wayside is a power supply/battery charger. The Trainphone radio operates from nominal 36 volts DC, so a unit is required to convert 117 volts AC to this DC voltage. Also supplied is power to a floating battery of Nife nickel-cadmium cells. The battery will operate the wayside equipment in excess of 8 hr at a 20% duty cycle in event of primary power failure. The battery has 5-cell trays mounted in the bottom of the wayside equipment case.

RF energy transmission between the wayside and mobile Trainphone radio sets is via telephone cable transmission and traction power circuits in the third rail. All RF energy must pass through a car-carried coupling unit which is provided as a safety item. It prevents any DC traction high-voltage from connecting to the Trainphone. The unit contains a fuse, DC blocking capacitor and an inductor which has low DC and high RF impedance. Wayside track couplers are used to couple the wayside equipment to the tracks and bridging units are used to insure that the RF signal will be bridged across an open DC traction circuit.

At Lindenwold yard, a local control handset and speaker are in the wayside case. This zone is used as a local control station between the yard office and yard movements.

For each train unit (a married pair of cars or a double ended single car), there is one Trainphone radio (transmitter/receiver/PA), one coupler and two sets of control equipment. The two control panels are identical and wired to the common Trainphone unit by plug-connected train line cabling. The panel is flush-mounted on the car console, and contains a handset, handset hangar, volume control, PA (public address) switch, plus PTT (push-to-talk) button, and receive illuminated indicator assemblies with brightness control. The speaker associated with the panel is separately mounted behind a grill on the vertical portion of the train console. In operation, an incoming call is heard on the monitor speaker. Removing the handset from the hangar to acknowledge will transfer all audio to the handset receiver until it is returned to the normal hangar position. Push-to-talk control is by a switch in the handset.

Public address conditions are twofold. First, with the handset on hook and PA switch in PA position, all received audio will be switched to the PA amplifier and distributed to PA speakers throughout the train via the 70-volt audio line. This condition allows the central dispatcher to give information or directions to the persons riding the train. Second, with the handset off hook and the PA switch in the PA position, the train attendant may make announcements to his train by using the handset microphone.

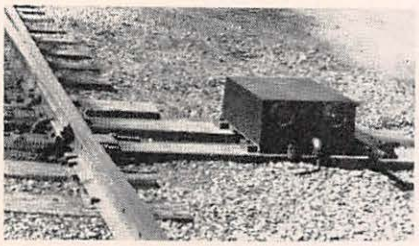
For protection to RF equipment, an RF choke is placed in series with heater elements on the cars. Many of these elements are of low DC and RF impedance and shunted directly across the traction circuits for operation. To accomplish the protection, an RF choke with a maximum rating of 90 amp DC is used.

Each passenger station is equipped with a 150-watt solid state public address amplifier and an associated group of speakers to fully cover the station building and platform areas. The amplifier has two inputs, 150-ohm dynamic microphone for use by a local station agent (not used) and a telephone line input for remote audio and control from Center Tower. When the central dispatcher exercises priority access, a two-second tone warning proceeds any voice announcement.

The PA system is powered by a rectifier-battery supply similar to that used by the wayside Trainphone.

The central dispatcher line amplifier is also fully solid state and is rectifier-battery operated. The equipment has capability of simultaneously operating one or more (including all) station public address amplifiers. Following selection of desired stations, depressing the "operate" switch will cause transmission of the alert tone. Upon completion of the tone, a ready lamp becomes illuminated and voice transmission may start. Release of the "operate" switch returns the system to standby condition.

Product News



Switch machine works on 115/230 volts AC (101)

Designed for noninterlocked service, such as in receiving and departure yards, and industrial yards, the Speed-Frater electric switch machine is power-operated from 115 or 230 volts—or can be hand operated by means of its convenient built in lever. It is trailable, reversible in midstroke, and has internal contacts for indicating its position. Options include indicator lights built into the deep-sided cover, and automatic restoration, in case of an obstruction in the points. Operating time of the Speed-Frater is well under one second. It has a maximum—and adjustable—throw of 5½ inches. With cover removed, all parts are easily accessible for inspection and maintenance. *General Railway Signal Co.*

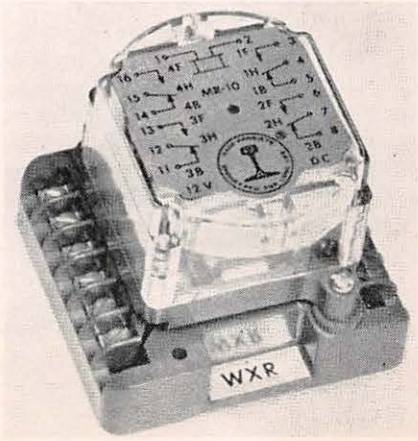
FM two-way radio has 4-channel ability (102)

Designated the MOCOM 70 radio, this solid state FM two-way mobile unit has up to four frequency capability and is available with 30 and 45 watts RF power output in high band and with 50 watts output in low band. With its all solid state design, this new radio has no tubes and no power supply—assuring cool, reliable operation, longer component life, and a minimum of maintenance. This design feature also means instant communications since no warm-up is required. Low current drain, consistent power output and continuous duty capability are other benefits. The sensitivity of the radio—0.3 uv in low band and 0.35 uv in high band—provides improved range and increased effectiveness. The MOCOM 70 radio also provides maximum protection against adjacent channel interference with selectivity of more than 80 db down in low band and more than 90 db down in high band. *Motorola Communications & Electronics, Inc.*

Inband signaling works on wire, carrier, MX (103)

The B850 inband signaling systems provide the means for transmitting E & M dial, one-way loop dial, or foreign exchange signaling information over cable carrier, microwave multiplex, open-wire line carrier or a four-wire physical line facility using 2600 Hz for supervision and dial pulse information. All B850 transistorized signaling equipment is electrically equivalent to and will work on an end-to-end basis with the various types of Western Electric E type signaling systems. The B850 signaling system is very economical for either high or low density requirements because it does not utilize any common equipment. Each unit is complete in itself, including individual 2600 Hz tone generators. Various types of signaling units may be housed in the same equipment cabinet and exchanged according to individual requirements. The B850 signaling system is also available in a variety of completely wired and tested 11 ft 6" or 9 ft bays with inter-unit cabling, top-of-bay terminal blocks, jackfields, carrier group alarm facilities, a fuse and alarm unit and optional built-in (or external) terminating sets as required.

Features include: Talk Off—Immunity against false disconnect by a speech simulated signal has a probability of less than one in 10,000 calls according to actual field installation results. Receive Pulse Correction—All B850 inband signaling units contain receive pulse correction and field tests have shown that the receive dial pulse regeneration produces essentially 100% dial pulse correction. Transmit Pulse Correction—Minimizes dialing errors and eliminates customer complaints with a guaranteed tone pulse length of 45 milliseconds (±5) when dial pulse speed exceeds 10 pps for all B850 signaling units except the E4B, E & M dial type. The E4B, E & M dial type provides a minimum of 50% tone ON during pulse duration producing essentially 100% transmit pulse corrections at 14 pps. Transmit Pre-cut—In addition all signaling units containing transmit pulse correction use a feature known as Transmit Pre-cut which delays the outgoing 2600 Hz tone burst by 20 milliseconds. This allows the transmit cut relay time to operate, which prevents tone pulse distortion caused by transients from the drop equipment. *Lynch Communication Systems Inc.*



New relay is for grade crossing logic (104)

A new relay used in conjunction with a grade crossing relay logic unit is the MR-10. It features silver impregnated carbon front contacts, positive non-magnetic armature stop, gravity and redundant spring armature return, wide contact opening, and complete isolation of contacts and plug-in feature. The relay was designed for long life, and meets all significant specifications. (AAR—Spec

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47	**48**	**49**	**50**	**51**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**
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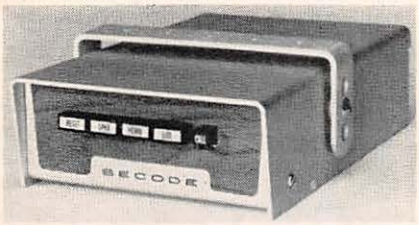
204-44) for tractive armature direct current neutral relay plug-in type. The MR-10 is small in size—3" high x 3½" wide x 2⅞" deep—and is convenient to use; it plugs in, pulls out. *Railroad Accessories Corp.*



Digital unit selects codes for radio (105)

Applied to 2-way radio systems, the SD-40 digital decoder selects from 6,561 discrete codes to alert one individual of his calls. It sounds the horn, starts four-way flasher systems, opens a speaker and lights a call lamp so that even an unattended mobile unit gets the message. Additional memory is provided for an emergency "all-call" and up to 64 "group-call" codes in each SD-40. Code changes are programmed in the field without the need for extra cost plug-in elements, reeds or modules to stock or exchange. A unique digital filter and error detector circuit assure highly reliable signaling, even in conditions too poor for voice. *Secode Electronics.*

Data unit has key punch and transmitter (106)

Data terminal which consists of a key punch and transmission equipment to prepare and transmit punch cards is described in bulletin TPD 5708. The bulletin describes Telecard I which can transmit punch cards at a rate of up to 200 wpm or receive punch card information from a distant terminal. Key punching is of a speed of 25 characters per second. *Oneida Electronics Inc.*

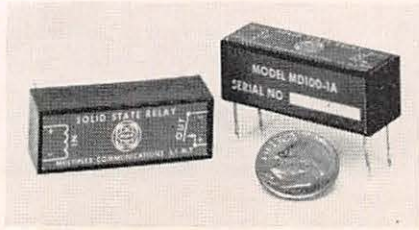
Surge unit protects to 800 striking volts (107)

Button type surge voltage protectors are available with rated DC striking voltages ranging from 90 to 800 ±15%, while surge striking voltages range from less than 1 kv to 4 kv. Rated surge discharge current for a $\frac{8}{20}$ microsec wave is 5 ka. and 1 ka for $\frac{10}{250}$ microsec wave. Rated AC discharge current is 5 amp.

Other surge voltage protectors have rated DC striking voltages ranging from 230 ± 15% to 1400 ± 15%. The surge striking voltage range is less than 2 kv to less than 3 kv while the rated surge discharge current is 20 ka with a $\frac{8}{20}$ microsec wave. Rated AC discharge current is 40 amp and the maximum follow-on current for one half sine wave at 60 Hz and 110 volts rms is 160 amp peak. *Siemens America Inc.*

Data modems serve 2-wire private lines (108)

New T103F and T103FS series data modems are available. The T103F is designed for use on two-wire private lines; the T103FS operates on the two-wire DDD switched network via the manual data access arrangement. Both data sets operate at speeds to 300 bits per second, full-duplex. Featuring EIA RS-232-B receiver and transmitter interfaces, the T103F series also includes a strappable 20 milliampere driver and local copy. The transmit data lead accepts dry contact closure inputs. Both the Sangamo T103F and T103FS data sets are line-spectrum compatible and will operate end-to-end with Western Electric 103 series data sets. *Sangamo Electric Co.*



Computer switch or relay is solid-state (109)

The MD/Series are completely solid state devices designed to work as a relay or switch in computer, communications, and other mediums. Components are packaged in a container which is completely encapsulated and ideally suited for printed card use. Encapsulation enables use of the unit under extremely humid and volatile conditions. Because of its resistive input, normal relay magnetic coil kickback and radiation are eliminated. The solid state output eliminates relay contact bounce and chatter which serve to produce operationally destructive noise. The MD series will operate with current input of 800 microamps and of voltage input from 2.5 volts and up. The unit will handle speed ranges from DC to as high as 6,000 baud. *Multiplex Communications Inc.*

FM radio is base station or portable unit (110)

A new compact, readily movable Porta-Mobil FM two-way radio base station is available with AC power as well as battery packs for hand-carried portable use and installation in a vehicle. The equipment is designed for semi-fixed applications such as temporary headquarters. It may be used in 25-50, 132-174, 406-420, or 450-470 MHz systems.

When used in an office, the upper portion of the solid-state Porta-Mobil equipment containing the transmitter and receiver is secured on an AC-operated power supply by two clamps. The radios may be converted to a portable or a mobile combination for communications system flexibility by the use of different power supplies.

Electronic voltage regulation compensates for AC line voltage variations up to ±20% of nominal input level for consistent, dependable message communication, on-frequency operation, reliable receiver sensitivity and high transmitter drive. Low-distortion audio is delivered through a built-in weather-protected speaker. Porta-Mobil base stations include noise-canceling microphones, handsets, two-frequency transmit, two-frequency receive, solid-state Channel Guard, decoding equipment, accessory jacks and application cables. *General Electric Mobile Radio Department.*

News Briefs

Electrification tops IEEE-ASME meeting

As railroads face the problem of providing safe efficient transportation for an increasing volume of freight movement to satisfy the needs of an ever growing population which also demands the rapid moving of people they turn to large scale electrification as a possible solution. This problem is not confined to the United States and it is appropriate that major railroads of the world learn from each other and examine the experience each has had with high-voltage commercial frequency electrification for moving people and goods in long distance intercity travel.

Representatives of major European and U.S. electrified railroads will share their recent developments and plans for the future.

Damage free transport of goods is a major interest to both the shipper and the carrier. The mitigation of freight loss and damage caused by longitudinal shock is of interest to the rail mode of transport.

A series of papers will explore the theoretical approach to solve the problem, the practical design of hardware, the evaluation of hardware and a review from the shippers standpoint.

This conference, which is a joint activity of the Land Transportation Committee of the Institute of Electrical and Electronics Engineers (Industry and General Application group) and the Railroad Division of the American Society of Mechanical Engineers, will be held April 7-8 at the Sheraton Hotel, Philadelphia, Pa.

Session I—(April 7)—Operating Experiences and Future Plans for Electrified Self-Powered and Locomotive-Hauled Trains: The European Approach. Speakers include F. F. Nouvion, French National Railways; Prof. Dr.-Ing. A. Kniffler, German Federal Railways; and A. Chernish, Russian Department of Internal Communications.

Session II—U.S. Northeast Corridor. Speakers include R. B. Watson, Penn Central, who will discuss Metroliner Train Experience; Kenneth B. Ullman, DOT, and J. C. Brown, General Electric Co., who will speak on Metroliner Car Systems.

Session II (April 8)—Existing and Proposed Systems for AC Electrification: H. D. Suddards, T. H. Rosbotham and T. A. Bamford, British Insulated Callender's Construction Co., Ltd., will speak on Catenary Systems for High-Voltage AC Railroad Electrification; W. P. Rees, English-Electric-AEI Traction Ltd., will speak on Design of High-Output Electric Locomotives for the U.S. Railroads. H. J. Wefers, General Electric Co. and L. E. Ettlinger, American Electric Power Service Corp. will speak on Modern Railroad Electrification at Muskingum.

Session IV—Mitigation of Freight Loss and Damage Caused by Longitudinal Impact: Prof. F. Freudenstein, Columbia University will talk about Dynamic Analysis of Long-Travel, High-Efficiency Shock Absorbers in Freight Cars. V. T. Hawthorne, Keystone Railway Equipment Co., will discuss Freight Car Cushioning with Variable Orifice Hydraulic Shock Absorbers. Cushion Performance-In-Service Evaluation will be made by R. W. Luebke, Chesapeake & Ohio. S. R. Pierce Michigan State University, will discuss The Effects of Impact on Packaging from the Consumer's Viewpoint.

Telpak rate increases were effective Feb. 1

Telpak rate increases totaling $64 million per year went into effect Feb. 1, after a U.S. Circuit Court of Appeals denied efforts of users to have the changes stayed or enjoined. The new Telpak rates were to have become effective Nov. 1, 1969, but the FCC suspended the effective date for 90 days. Telpak users wanted the period extended again to allow them more time to change to private line or other services. But the court denied extension of the effective date.

Rate increases, for example, rise from $28 to $30 per month per mile charge for Telpak C (type 5700, 60-voice channel equivalent). For Telpak D (type 5800, 240-voice channel equivalent), the rate goes from $60 to $85 per month per mile charge. Voice and teletypewriter terminals would be $35 a month for the first station in an exchange, compared with the present $25, and $15 for subsequent stations, against $10 monthly now.

Sectional meets for St. Paul & Cincinnati

Communication & Signal Section AAR will hold two sectional meetings this year. The western sectional meeting will be held Wednesday, April 15 at the St. Paul Hilton hotel. Chairman is C. H. Wesman, engineer of communications, Great Northern, and committee of direction sponsor is D. C. Hill, superintendent communications, Northern Pacific.

Eastern sectional meeting will be held at Netherland Hilton hotel in Cincinnati, Ohio, on Thursday, May 21. Chairman is E. E. Webster, Jr., assistant signal supervisor, Louisville & Nashville, and committee of direction sponsor is E. A. Burgin, superintendent of signals C&O/B&O.

C&O/B&O orders two-way radio sets

Diesel-electric locomotives, operating on the Chesapeake & Ohio or Baltimore & Ohio, will be receiving new solid state railroad radio sets and accessories. The C&O/B&O has ordered 220 model 3R radio sets and 200 accessory items from the Signal & Communications Division of WABCO.

BART test cars to run in control check

San Francisco Bay Area Rapid Transit District test track laboratory cars will return to service this spring in a final check-up of the automatic control system. Westinghouse Electric Corp., which received a $26-million contract for BART's automatic train control and communications equipment, will conduct the test runs under an addition to the contract. The addition provides for modification of two laboratory cars and equipping them to run automatic train control tests. Reasons for the test are that this will provide checking out of the automatic train control system prior to arrival of prototype BART cars now being manufactured by Rohr Corp. Ten of these cars are to be delivered in late fall of this year.

FCC hears arguments on Telpak sharing

Oral arguments were presented to the Federal Communications Commission about the recommended decision of Common Carrier Bureau Chief Bernard Strassburg which concluded that the existing sharing regulation is discriminatory, and would call on the American Telephone & Telegraph Co.

and Western Union Telegraph Co., adopting the AT&T telpak tariff for competitive purposes, to eliminate the discrimination.

Telecommunications Reports said a key issue was as follows: "Urging continuation of the present limited sharing eligibility—essentially, government and regulated public utilities—counsel for present sharers declared that unlimited sharing will lead to the demise of Telpak while elimination of sharing would greatly reduce the economic utility of the offering to them."

"For the Association of American Railroads, Roy R. Russo said the concept of favored industries is 'engrained in our history' and cited land grants to railroads as an example. He emphasized that as a regulated industry, railroad expenses directly affect the rates that are charged, and he observed that all members of the public 'use the railroads' in terms of products shipped that way.

"Asked by FCC Commissioner Cox if he were arguing that railroads should have sharing because the savings are passed on to the public, or because they might otherwise shift to private microwave, he answered the first part affirmatively. The second consideration, the AAR spokesman declared, is really the Bell System's concern, rather than the users."

Santa Fe microwave net near completion

A new 685-mile microwave system is being completed with the installation of nearly 100 solid parabola antennas made by Mark Products Co. The system, engineered and constructed by the Santa Fe extends from Riverdale, Kan., to Silsbee, Tex. The new microwave system includes 27 antenna sites. The antennas incorporate a patented circular waveguide feed, which is driven by the Mark Isopolarizer. This unit is designed to permit fast field polarization adjustment. The parabolas are made of spun aluminum and are designed to withstand 125 mph wind loadings.

Radomes are used with each antenna to provide additional protection from wind and debris, which could cause undesirable signal attenuation. In addition, the aerodynamic shape of the radomes improves front wind-loading characteristics of the antenna installation. The Santa Fe system, upon completion of the Riverdale-Silsbee segment, will total 3,201 miles of private microwave communications.

Bell considers user to supply data sets

Bell System will consider permitting customers to supply their own data sets when using Bell private line services. AT&T is also planning to provide entrance facilities for customer-owned communications systems at greater than voice band. The telephone company, at an informal FCC conference, stated that a mileage limitation similar to the present 25-mile requirement for series 10,000 entrance facilities is necessary, and that AT&T cannot go along with any proposals permitting the "piecing out" of interexchange routes through the use of customer-owned microwave facilities between two or more sections of telephone company facilities.

Syntonic Technology serves railroads

Syntonic Technology, Inc. will install, and subsequently provide service and maintenance for, two-way communications equipment to be used by the Monongahela, the Montour, and Pittsburgh, Chartiers & Youghiogheny railroads. Both base station and mobile equipment (both portables and fixed-installation gear in locomotives and cabin cars) are involved in the contracts.

Syntonic has provided a variety of communications equipment on lease/maintenance contracts to the Penn Central for a number of years and, in addition, special systems for the Reading and Lehigh Valley railroads.

NYCTA orders signal equipment for yard

New York City Transit Authority awarded a $5.4-million contract to General Railway Signal Co. for equipment and controls on 1.5 miles of line from Stillwell avenue to West 8th street and Stillwell yard in New York City. A GRS route-type interlocking machine (NX) will be located at the Coney Island yard tower for direct wire control of the Stillwell yard interlocking. Other equipment to be supplied includes model 5 electric switch machines, type AW colorlight signals and AC train stop units.

SCL orders radio for new locomotives

New diesel electric locomotives, operating on Seaboard Coast Line will be equipped with solid-state radio units. SCL has ordered 60 sets of model 3-R radios from the Signal & Communication Division of WABCO.

New Structure and TWX: new for WU

Western Union Telegraph Co. has become a subsidiary of a newly formed parent company, Western Union Corporation. WU chairman and president, R. W. McFall, said: "Through this corporate restructuring, Western Union now will have the management and financing flexibility necessary to meet the technical and competitive challenges of the Seventies and to take full advantage of future growth opportunities by means of mergers and acquisitions as well as internal development."

In another announcement Western Union told the Federal Communication Commission that under certain conditions the company would permit connection of customer-provided terminal equipment to Bell System's Teletypewriter Exchange Service, if and when Western Union acquires TWX. Thomas F. McMains, vice president and special assistant to the chairman of Western Union told the Commission that Western Union's position applies to private-type TWX communications networks and the much larger public Teletypewriter Exchange Service of TWX. He said the company is willing to permit interconnection to TWX's Public Exchange Service only if approved types of customer-provided terminal equipment are used. Line connections for both types of service must be made through a TWX network control and protective device provided by the telephone company.

In addition, McMains said, the related FCC-approved pricing structure must permit fair competition between WU and others supplying and maintaining customer-provided terminals.

People

MILWAUKEE ROAD: J. J. Janusz appointed assistant manager computer operations at Chicago.

MISSOURI PACIFIC: Guerdon S. Sines, manager of management information system-development, appointed director of information and control systems.

TERMINAL RAILROAD ASSOCIATION OF ST. LOUIS: J. E. Pinson appointed director, management planning and development.

Suppliers

ABEX CORP.: Thomas W. Russell, Jr., president, elected chairman of the board and chief executive officer, succeeding William T. Kelly, Jr., retired. N. George Belury, first vice president, named president. John L. Devaney, Jr., sales representative, Houston, transferred to San Francisco and is succeeded by Arthur M. Taylor, sales representative at St. Louis. Norman W. Smith, sales representative, Philadelphia, transferred to St. Louis. All three salesmen are associated with the railroad products group.

Robert C. Fish
Gen. Ry. Signal

Mark H. Sluis
Gen. Ry. Signal

GENERAL RAILWAY SIGNAL CO.: Mark H. Sluis, manager of product engineering, appointed vice president-engineering. Robert C. Fish, assistant to the president UMC Industries, appointed vice president-finance. Gary J. Mitchell, controller, marketing division Olivetti-Underwood, appointed contracts manager.

OKONITE COMPANY: V. L. Garrison, plant manager, Wire and Cable Division's Patterson, N.J. facility, appointed director-engineering services. Howard M. Williams, Jr., appointed manager Birmingham district sales.

RCA COMMERCIAL ELECTRONIC SYSTEMS DIV.: Vincent J. Keenan, appointed manager, Eastern Field Sales, in Pennsauken, near Camden, N.J. Robert E. Sirls appointed manager Central Field Sales, with headquarters in Cincinnati, Ohio. Willard K. Shaw appointed manager Western Field Sales, Hollywood, Cal.

(Please turn to page 36)

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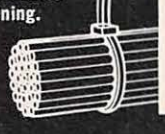

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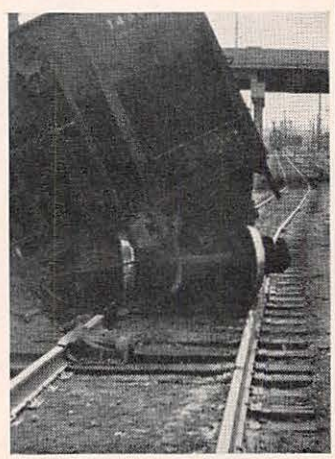

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Track safety devices that WORK at the job.

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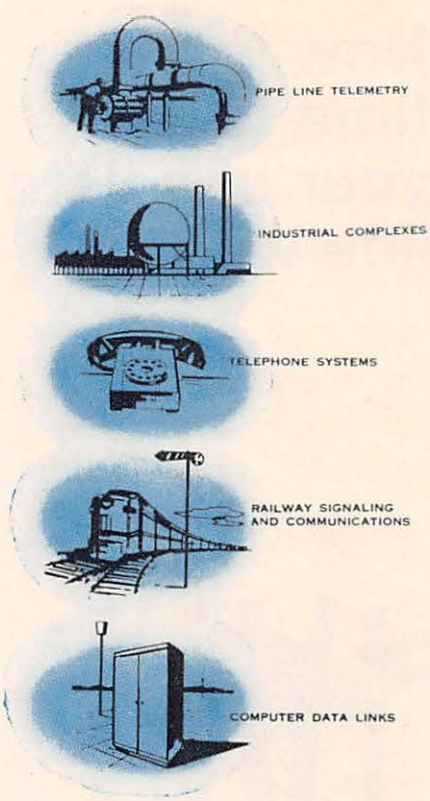

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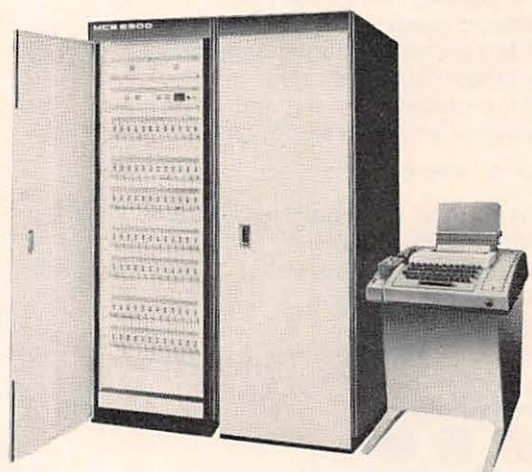

- TRUE PAY-AS-YOU-GROW EXPANDABILITY. No longer must you add channels in blocks of 12 or more when expanding. MCS-6900 lets you add even one channel at a time – and at a fraction of present costs.
- EQUIPMENT COMPATIBILITY. MCS-6900 interfaces directly with existing telephone systems because it is Bell T-1 and WECO-D1 compatible.
- SYSTEM ECONOMY. PCM system eliminates costly group equipment required for FDM systems. In addition the MCS-6900 eliminates expensive common PCM multiplex equipment. What's more, drop and insert capabilities at repeater stations cost 50% less than the same capabilities in existing systems.
- FIELD-PROVED. The MCS-6900 was developed from existing Canadian Marconi Company equipment, techniques and systems field-proved in the most hostile of enviornments. Six basic functional units, grouped as required, make up the entire system.

For complete information write today to Telecommunications Division, Canadian Marconi Company, 2442 Trenton Ave., Montral 301, Quebec or call (514) 343-3411.

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Eastern D.M.C.
Tamaqua, Pennsylvania
Liberty Smelting Works Ltd.,
Montreal, Quebec, Canada

Circle 13 on reader service card

PEOPLE

(Continued from page 34)

INTERNATIONAL COMMUNICATIONS CORP.: Matthew A. Kenny appointed director of sales and **Jack B. Gerber** appointed director of marketing.

OKONITE CO.: H. R. Stewart, Jr., manager sales at Charlotte, N.C. appointed manager of sales at Houston.

RADIO CORP. OF AMERICA: Irving K. Kessler appointed executive vice president defense and commercial systems and will assume operating responsibility for the commercial electronics systems. **Andrew F. Inglis** appointed division vice president commercial electronic systems.

VAPOR CORP.: Carl Krisco appointed engineer supervisor for electrical systems in the transportation systems division.

SIGNAL & COMMUNICATIONS DIV. WABCO: Robert M. Karow, manager marketing services, appointed manager market planning and development. **Charles E. Stipancic** manager of market research and product planning, appointed manager railway markets.

Robert M. Karow
S&C Div. WABCO

Charles E. Stipancic
S&C Div. WABCO

HARMON ELECTRONICS INC.: Donald V. Rentz appointed vice-president manufacturing succeeding William T. Pinet, retired.

S&C Man Wanted

Midwest terminal railroad needs signal and communications engineer with previous supervisory experience. Knowledge of interlocking and code systems essential. Send resume of work experience and education, and salary requirements to *Box 267 Railway Signaling & Communications, 29 E. Madison St., Chicago, Ill. 60602.*

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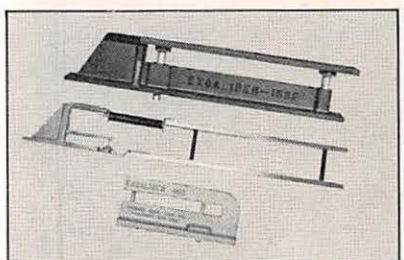

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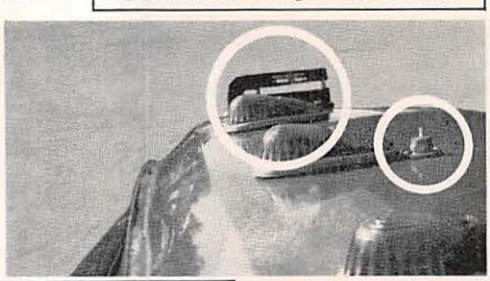

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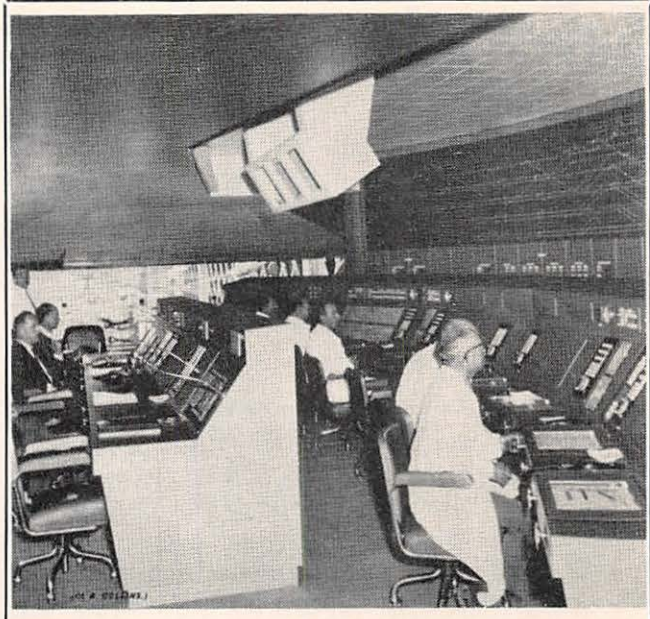

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publiscope

Circle 11 on reader service card

Editor's Corner

Training is "in"

From locomotive simulator programs to safety lessons, railroads are in training and personnel development in a big way. "Training" is an "in" word today. In many areas, especially involving the maintenance of equipment—signals, telephones, locomotives or cars, for example—rail managers are finding that they can't afford not to train men to fill maintenance technician positions.

There is considerable training in progress in many railroad departments. A close look reveals that it is most often treated as a departmental prerogative. For example, fundamentals of electricity will be taught to fledgling diesel mechanics, car department electricians, signal helpers, communications men and apprentice electricians. On some railroads, these very similar courses are being taught simultaneously by the various departments. Often, each department sets up its own training programs.

A bird's-eye-view, so to speak, reveals that much of this duplication of effort by various departments within one railroad is also being duplicated by many railroads.

SPECIALIZATION IS NECESSARY

A signal man, communications or electronic technician, diesel mechanic or electrician are specialists. This view contends that the traning must be tailored to meet the needs of the individual job qualifications. Therefore, each department can best handle its own training requirements.

On the other hand, there appears to be some merit to the idea of providing—at least in areas of common interest, such as electricity—a basic course that would be applicable to all these specialists. Immediate advantages would be sharing of training costs among various departments, with the cost per man being reduced. Fewer instructors would be required.

How many railroads are "re-inventing the wheel," because each considers its own problems unique and unsolvable using anyone else's experience or solutions?

There are some fine AAR efforts carried out by the Communication and Signal Section which has produced recommended practices for the application of signal and communications equipment. Its recommended practices for highway grade crossing protection equipment are universally accepted by state and federal governments as the standards to be applied. The Data Systems Division, AAR, has worked on the development of the Standard Point Location Code, and the Universal Machine Language Equipment Register, to name just two.

INDUSTRY-WIDE APPROACH NEEDED

Now is the time for an industry approach to training. Creation of a training and personnel development office in the AAR would be an important first step. Advantages of this industry-wide approach include:

- Duplication of effort by individual railroads would be reduced.
- Cost of training per railroad could be reduced through AAR coordination and direction.
- Sharing of costs of AAR sponsored training programs could be based on proportion of participation.
- Professional staff of training and personnel development people could advise and prepare training material that could be sold to individual railroads at cost.
- T&PD office in AAR could become central clearing house for information exchange on training and personnel development.
- Financing for industry-wide training programs may be obtained from state and federal governments. Railway suppliers might find it to their advantage to participate. Help from suppliers is underway in the trucking industry. The Automotive Division of Budd Co., has contributed $100,000 to the American Trucking Association Foundation to distribute a 770-page handbook at no cost to about 4,000 motor carriers to detail computer applications to the trucking industry.

A nucleus is already established for training in the AAR. The Communication and Signal Section has a Committee G—Education and Training. This group could work with an AAR training and personnel development officer in providing guidance in its area of specialization.

The AAR should acquire a full-time professional staff for training and personnel development. It certainly would be more economical and more effective than the present duplication of efforts conducted by individual railroads. Also, and more importantly, a highly-skilled and properly trained maintenance force would result.

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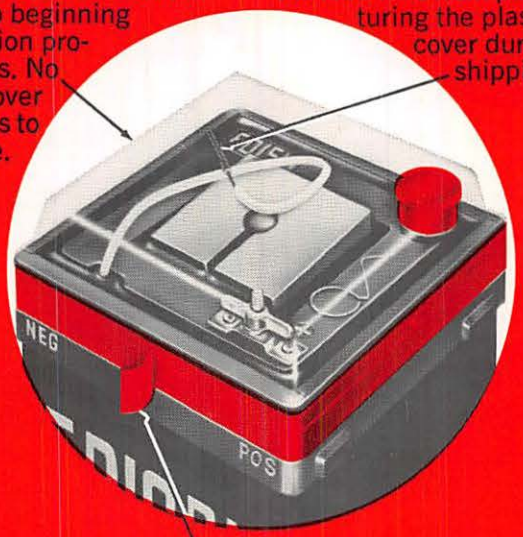
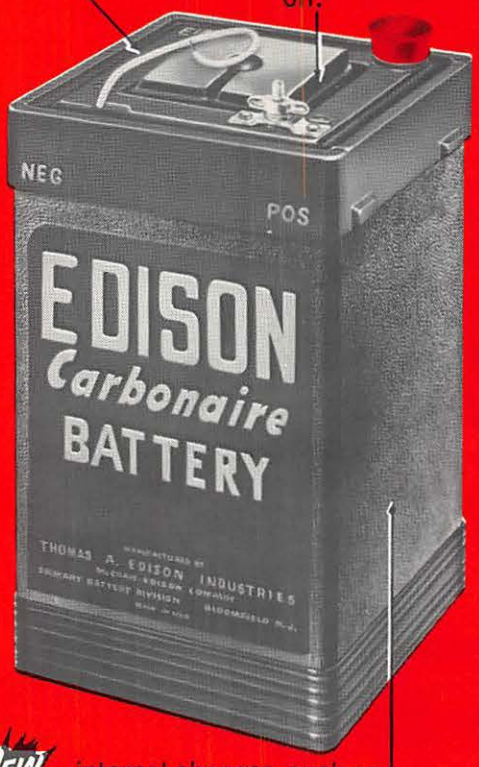


NEW . . . tape seal for cover which is easily and quickly pulled off, starting at this tab.

NEW . . . Teflon coating on top of the carbon to substantially increase the carbon's resistance to surface wetting.

NEW . . . raised and slanted carbon to allow any liquid that accidentally gets on top of carbon, during service, to run off.



There has been no change in the electrical characteristics of either battery. Voltage, capacity and discharge capabilities remain the same. Standard tests, such as the use of the Edison Carbonaire Battery Test Meter, also remain the same.

Taken together, however, these changes represent a substantial improvement in both operating efficiency and dependability over previous models of the TR and Y batteries . . . and are the latest practical results of our continuing research.

NEW . . . internal changes, such as:

1. Improved carbon support, made of high impact insulating plastic, to reduce carbon damage due to vibration and shock.
2. Elimination of the filler tube to provide easier, faster activation.
3. The addition of four transport tubes — one in each corner of the battery — to increase circulation of the electrolyte during battery discharge thereby assuring more uniform utilization of the lime.

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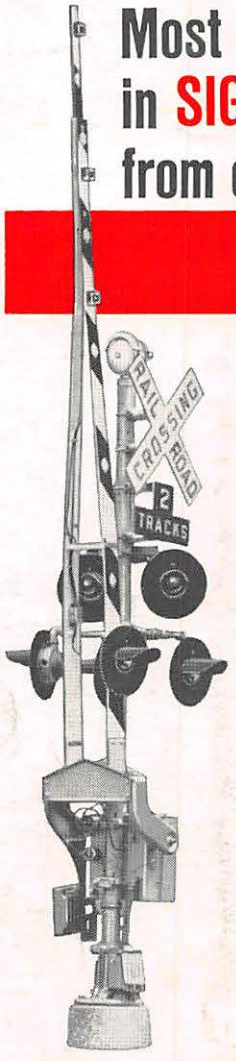

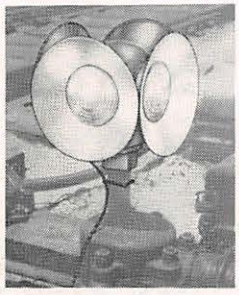

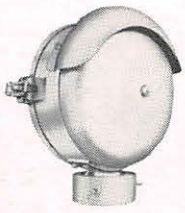

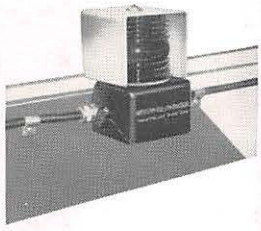

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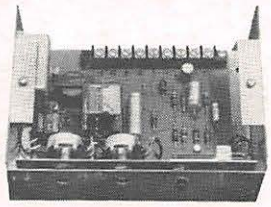

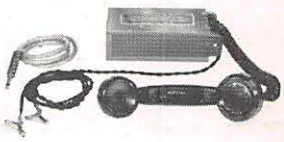

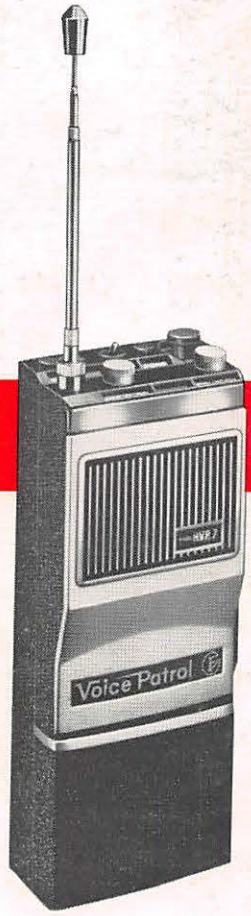

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